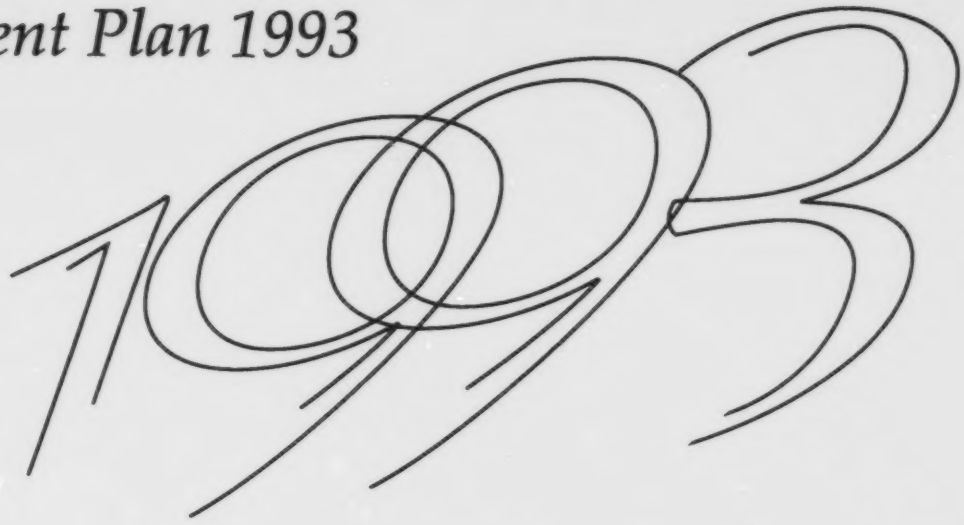
Development Plan 1993

PROPOSAL



Montréal, October 30, 1992

Madame Lise Bacon
Deputy Prime Minister and
Minister of Energy and Resources
5700, 4e Avenue ouest
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Charlesbourg (Québec)
G1H 6R1

Dear Madam,

I am pleased to submit to you our proposed Development Plan 1993.

This document is the result of a process based on analysis and dialogue. It was shaped by our customers' expectations and by the viewpoints of the many and various groups we consulted throughout the year.

The orientations we are proposing take into account our customers' concerns with the cost and quality of service, as well as expectations about Hydro-Québec's role with regard to both economic development and sustainable development. The proposed orientations are those which we feel, all things considered, are the best for our customers and for Québec society as a whole. We also believe they are in line with the general principles of the Québec government's energy policy.

This document is intended to promote open and fruitful dialogue during the parliamentary committee hearings to be held next spring. In this way, we hope to contribute to ensuring the best possible future, in terms of electricity, for our customers and Quebecers at large.

Yours respectfully,

Richard Drouin
Chairman of the Board and
Chief Executive Officer

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Foreword

This document marks an important stage for Hydro-Québec.

In the past, the utility submitted to the Québec government an annual Development Plan setting forth its long-term orientations. In 1991 the government changed that process: henceforth, the Development Plan is to be tabled every three years to permit more in-depth studies and a broader consultation with all interested parties.

This is therefore our first three-year proposed Development Plan. It will be followed, early in 1993, by our Performance Commitment, a document that will present our performance objectives for 1993, 1994 and 1995, along with the electricity rates we envisage for that period. A complementary document will specify the terms of our 1993 rate proposal. Both the Development Plan and the Performance Commitment will be examined in the spring of 1993 by an enlarged standing committee of the National Assembly of Québec.

Early in 1994 and 1995, follow-up reports will discuss the results achieved with respect to our commitment and our rate proposals.

Certain aspects of the proposed Development Plan are covered in greater detail in a series of documents which are more technical in nature. A complete list of titles appears on the back cover of the Plan, as well as information on how to obtain them.

The proposed Development Plan and related documents are intended to advance the discussion of the future of electricity in Québec. We hope they will contribute to an open and productive dialogue on this important issue.

Summary

As Québec's supplier of electricity, Hydro-Québec serves most of the population on a daily basis. We are above all a public utility – hence a business that listens.

Our activities involve us in an ongoing dialogue with several types of interested parties. All our orientations and actions must take into account the expectations of various groups: our customers, of course, but also communities affected by our construction projects, citizens' groups interested in our activities, and the Québec community as a whole.

A SERVICE-ORIENTED ENTERPRISE

We have not always been equal to the task of meeting those expectations. However, in the late 1980s, we took a hard look at our performance. And we have taken measures to turn the situation around.

This turnaround is now well under way and, in many respects, has already been achieved. We have reached the objectives set for certain aspects of our service, such as rapid connection to the power system and telephone access to our offices. As for service continuity, improvements continue to be made as planned. Our objective in this area was to equal the average performance of Canadian electric utilities by 1995, and we are well on our way.

Our overall customer satisfaction rate has increased from an average of 62% in 1990 to almost 85% in 1992.

But we intend to go much further. We want our customers to recognize us, by the year 2000, as Canada's foremost electric utility in terms of quality of service. Thus we must regularly compare our results with those of the most efficient utilities and ensure optimum management of costs, since our customers are not prepared to see improvements made at any price. At each stage, we will have to listen to our customers and maintain the best quality-price ratio, in accordance with their expectations.

Thus since 1990 we have been involved in a vast project based on total quality management: *Défi performance* (performance challenge). The purpose of this initiative, which involves all our employees, is to achieve total customer satisfaction at the lowest possible cost.

To succeed, we are counting on the motivation and know-how of all our employees and on their embracing the quality culture. We are gradually setting up improvement teams and feedback mechanisms, and we are strengthening our know-how through an analysis of strategic skills, training and professional development.

The quality initiative involves an in-depth review of our practices and structures. In 1990, we divided our operating personnel into two specialized groups: Customers and Distribution, and Generation, Transmission and Telecommunications. The reorganization has already affected 18,000 people and will soon extend to the entire utility. Our objective is to restructure our sectors, regions and head office in relation to customers' needs, moving decision-making and action mechanisms as close to the customer as possible.

Our social, environmental and economic responsibilities to the community remain central to our concerns. We are continuing our efforts to protect human health and the milieux in which people live. Hydro-Québec will also continue to play an important economic role through its purchasing policy and support for research and development, in addition to sustaining jobs through its construction, operating and marketing activities.

Electricity supply and demand

As preparation for this Development Plan, we have consulted many groups over the past year on four fundamental matters: energy efficiency, means of generation, electro-intensive industries and electricity exports.

We intend to continue this productive process on a permanent basis, for it has enabled us to determine a range of options for the future of electricity in Québec. This document describes the various options and analyzes their economic and environmental impacts.

To meet future electricity needs, we will first improve the existing system and promote energy conservation by customers. We are maintaining our objective of 9.3 terawatthours (TWh) of annual energy savings by the year 2000. In the years to come, we will make a precise evaluation of the results of our efforts and make any necessary adjustments.

As for other means available to us, we will continue to emphasize hydroelectricity as our main source of generation since hydroelectric facilities offer distinct advantages in terms of costs, environmental impacts and economic spinoffs.

Nevertheless, the construction of hydroelectric facilities does affect local communities. We therefore propose to explain our projects better and to continue to harmonize them with the expectations of such communities. In particular, we intend to pursue, in an atmosphere of conciliation, discussions with the various Native communities affected by our projects, so as to reach agreements that allow all parties to achieve their aspirations.

Already, communities affected by the construction of generating stations or transmission lines receive the equivalent of 1 to 2% of the project cost to be used for environmental enhancement measures. In the case of generating stations, the scope of our funding will be broadened to promote regional economic development as well. Interested parties will be consulted on this subject.

We propose to use cogeneration and medium-sized hydroelectric generating stations as backup sources, given the planning flexibility they offer. To meet peak-power needs, we intend to maintain a balance between the addition of capacity at existing generating sites and load management, so as to minimize the installation of gas turbines.

In market development, we intend to promote electrotechnologies to increase the energy efficiency and competitiveness of Québec industries. We also recommend promoting the limited, targeted establishment of electro-intensive industries that meet specific criteria. Finally, we feel it would be economically advantageous to develop electricity exports, if certain criteria are met.

The orientations we propose involve a number of decisions. In this document, we state the probable dates when major decisions will have to be made in order to balance supply and demand within the scenario we have retained for planning purposes. These dates may vary, depending on how needs evolve over time.

We do not make recommendations regarding particular power plants or other specific generating projects beyond the year 2000. We feel it would be preferable to recommend, at a later date and in light of the orientations ultimately retained, the projects that appear most advantageous when decisions need to be made. Still, we do state the alternatives we favor if our proposals cannot be implemented in time.

THE PRICE OF ELECTRICITY

Our strategic orientations aim to meet a complex set of expectations and needs. But we must not lose sight of what is clearly our customers' major concern: the price of electricity.

Most of our residential customers have chosen electricity for water and space heating, and it represents a significant item in their budget. As for our industrial customers, they face intense competition because of global markets and lower prices for the fuels that are the main source of electricity outside Québec.

Our electricity rates are among the lowest in North America. From 1993 to 2000, we intend to align our rate increases with inflation. Although the increase may exceed the rate of inflation in some years, the average electricity-rate increase should not exceed the rate of inflation for the period as a whole.

Certain factors, such as changes in demand and interest rates, are beyond our control. But we do have control over others, especially increases in our operating expenses. Between now and the year 2000, we aim to equal the performance of Canada's most efficient electric utilities in terms of operating costs. We also intend to manage our investments rigorously and to increase our revenue through various measures, including the collection of bad debts.

In addition to aligning our rate increases with inflation, we will offer our customers energy-conservation programs so they can reduce their electricity consumption without sacrificing comfort. We will also develop seasonal rate formulas to promote a more rational use of electricity.

Finally, to offset fluctuation in runoff (inflows of water into our reservoirs), which is the main risk associated with our activities, we propose to create a stabilization fund. Revenue from surplus-energy sales during high-runoff years would be used to absorb special expenses during poor years. In this way, our customers will be better protected against rate shocks.

The orientations proposed in the Development Plan stem from the corporate vision adopted in 1991:

Between now and the year 2000, Hydro-Québec wants to become recognized by its customers as the foremost electric utility in Canada for the quality of its services. Hydro-Québec also wants Quebecers to recognize it as a major partner in the sustainable development of Québec. To achieve these objectives, the utility will make the most of its employees' know-how and Québec's hydroelectric resources.

A Utility That Listens

1

A utility such as Hydro-Québec cannot operate in a vacuum. To carry out its mission and to rank among the best utilities of its kind, it must maintain an open, ongoing dialogue with its customers, communities affected by its projects, citizens' groups interested in its activities, and society as a whole.

It is our responsibility to provide all the necessary information for a constructive discussion of our orientations and to explain our policies, projects and practices. At the same time, we must constantly listen. Over the past year, we have taken two important initiatives: one, a process for hearing customers out; the other, public consultation.

The customer feedback process took place in several stages in 1992. We first identified customer expectations through discussion groups comprising residential as well as commercial, institutional and industrial customers. We held individual meetings with large-power customers and neighboring systems. We also systematically compiled the requirements of the regulatory agencies whose decisions affect our operations.

After establishing the list of expectations, we conducted surveys and held individual meetings in which customers were asked to evaluate the importance of each item on a list. In this way we established the importance to our customers of the various services we provide.

From November 1991 to June 1992, we implemented a public consultation process for provincial groups interested in electricity. The discussions essentially covered four topics – energy efficiency, means of generation, electro-intensive industries and electricity exports – and about 75 groups took part. The main concerns raised during the discussions are explained in Chapter 3. A more detailed account of consultation activities is given in the annex entitled *Consultation Report*.

Any electric utility must construct generating stations and power lines, which inevitably have an impact on certain communities. Hydro-Québec therefore systematically holds consultations with local populations to minimize the adverse impacts of its projects, and to harmonize them as best it can with the expectations of those concerned. Two recent examples are the Ashuapmushuan and Sainte-Marguerite projects, located in the Lac Saint-Jean and North Shore regions.

Similarly, under the *James Bay and Northern Québec Agreement*, signed in 1975, we are negotiating with the Native communities affected by our hydroelectric projects. These projects have adverse impacts, such as the loss of hunting territories as a result of flooding and problems created by mercury in reservoirs. But we have found certain solutions to these problems in cooperation with the communities affected.

Moreover, the conditions of the Agreement and various subsequent agreements have benefited the communities concerned. For example, a range of positive developments accompanied Phase I of the La Grande complex: the Cree population increased (from 7,000 in 1976 to 12,000 today), living conditions and social programs improved, urban and road infrastructures were built, Native businesses were created, manpower training was provided, and an income-security program for hunters, fishers and trappers was implemented.

Our discussions with the Atikamekw and the Montagnais are continuing, and the memorandum of understanding reached in February 1991 during negotiations with the Inuit regarding the Grande-Baleine complex may lead to an agreement in the near future. In addition, we recently signed an agreement in principle with the Crees regarding certain projects that are part of Phase II of the La Grande complex, and the community of Waskaganish is involved in the draft-design studies for the Nottaway-Broadback-Rupert complex.

The Crees are now questioning certain aspects of the *James Bay and Northern Québec Agreement*. We are prepared to work with them to resolve these problems, in the tradition of conciliation that enabled us to reach the Agreement, whose overall impact remains positive from social, economic and environmental standpoints.

The dialogue must continue. Yet we must never lose sight of the larger issues shaping the future of electricity in Québec. On them depend the projects and schedules proposed in this document, as do the options that Quebecers are being asked to consider. In this context, we can only hope for comprehensive political settlements that, like the 1975 Agreement, will enable all parties to achieve their aspirations and pursue their development in all regions of Québec.

Finally, we intend to be more proactive in our efforts to communicate, not only in Québec but also internationally. In the latter case, we will intensify our efforts to ensure that the utility's position on all matters of international scope is clearly known.

A Service-Oriented Enterprise

As the province's supplier of electricity, Hydro-Québec is determined to satisfy fully the expectations of the population, businesses and institutions. These expectations concern not only product quality and customer service, but also, more generally, the direct and indirect effects of our activities on the quality of our customers' lives and the well-being of the community.

We have not always been equal to the task of meeting these expectations. In the late 1980s, we took a hard look at our performance, which prompted us to do an in-depth review of our practices and to find a new impetus.

The figures provide eloquent evidence of the turnaround we have effected in recent years. For instance, the average annual interruption time per customer (excluding exceptional events) dropped from 6.5 hours in 1989 to 5.3 hours in 1991. In this respect, we are well on our way to reaching the objective set in our last Development Plan, which was to equal the average performance of Canadian electric utilities by 1995. The accessibility of our telephone services has also improved considerably, with the rate of calls processed rising from 66% at the end of 1989 to more than 90% in the second quarter of 1992. Our customers recognize this progress: the utility's overall satisfaction rate increased from an average of 62% in 1990 to almost 85% for the first nine months of 1992, with a peak of 90% in the summer.

If we want to stand out as a utility, however, we must constantly strive to do better.

It was in this context that we launched an ambitious program called *Défi performance* in 1990. It involves an overhaul of our practices and structures according to the total quality principle, whereby we undertake to satisfy customers completely and at the lowest cost. Our success will depend above all on the motivation and know-how of the men and the women who work for Hydro-Québec. We have already implemented the means to better define and meet customer needs, and we intend to continue in this vein.

We want our customers to recognize Hydro-Québec, by the year 2000, as Canada's foremost electric utility for quality of service. This is our vision of the future. To realize it, we will have to achieve optimum cost management so we can always offer customers the best price-quality ratio, in accordance with their expectations.

The following pages define the major issues related to the expectations expressed by our customers, as well as the orientations we propose to fulfill them. Customer consultations could be held in coming years on such matters as type of services offered or the quality-price ratio. The Performance Commitment to be tabled early in 1993 will discuss our performance during the 1990-1992 period, along with the improvement targets we undertake to reach by 1995.

The subjects discussed in this chapter are:

- quality of customer service;
- product quality;
- the utility's environmental and social responsibility;
- human resources and management;
- research and development;
- investments required.

Electricity prices are discussed in Chapter 5, since they depend on the choices and orientations retained with respect to services, as well as supply and demand.

2.1 QUALITY OF CUSTOMER SERVICE

Our customers expect courteous, personalized service, prompt action and sound advice on electricity use. In this area, we have adopted two orientations.

Orientation 1

CONTINUE TO IMPROVE BASIC SERVICE AND MAKE IT MORE PERSONAL.

In the 1990-1992 Development Plan, we set a number of improvement targets. Objectives regarding speed of connection and telephone access have been reached and will be maintained. We are also continuing our efforts to increase the regularity of meter readings and the proportion of customers notified when service must be interrupted for maintenance or repairs. We will also improve the quality of our communications by further emphasizing courtesy, clarity and competence.

In addition, we are striving to make our customer relations more personal, for customers will increasingly expect to be served according to their specific needs and characteristics. We are re-evaluating our customer-service strategy from this standpoint. The strategy will take several variables into account, especially the geographic distribution of our customers and their demographic, social and cultural characteristics. Expectations can vary widely, depending on whether the customer is a person in a precarious financial situation, a new immigrant, a commercial customer or an essential service (hospital, police, fire department). In addition, certain groups — especially the elderly and those whose mother tongue is other than French or English — will constitute a larger percentage of our clientele. We must also consider reorganizing our services, for example by regrouping part of our workforce, to provide better service at lower cost. Still, activities involving direct customer contact will remain as close to customers as possible.

To improve the quality of our service, we must continue to train the employees who are in contact with customers. We are improving their work tools, especially through new technologies (voice mail, remote meter readings, etc.), following the examples set by the most efficient utilities.

Orientation 2

DO MORE TO HELP CUSTOMERS MANAGE THEIR BILLS AND CONTROL THEIR CONSUMPTION.

Most of our residential customers have chosen electricity for space and water heating. In fact, more than 70% of Québec households are heated with electricity, a level substantially higher than the average in the other provinces. Electricity therefore represents an important item in the budget of those households, especially in winter. Our customers expect us to help them manage the large seasonal variations in their electricity bills. In addition, an ever-growing proportion of customers in all sectors — residential, commercial, institutional and industrial — consider representatives of their electric utility to be the best-qualified energy-management advisors.

Our Energy Efficiency Project gives customers the advice and programs they need to limit their electricity consumption and to manage it more effectively.

In recent years, we have encouraged our customers to pay their bills using the equalized payments plan. The number of customers enrolled in this program increased from 9% in 1989 to 26% in 1992. We will continue to improve the program, notably by promoting automatic debiting (pre-authorized payments).

As for commercial, institutional and industrial customers, we want them to make the most of their relationship with the utility. We will be more proactive in explaining abnormal consumption variances, making annual visits to discuss contracts, and providing technical assistance to help customers manage their consumption more effectively and thus reduce their bills. We will also continue to offer training activities for construction professionals and others involved in energy efficiency, carry out technological demonstration projects, and pursue research and development.

2.2 PRODUCT QUALITY

Our customers have two expectations with respect to product quality: service continuity and power-supply quality. They would like to see fewer power failures (interruptions caused by unforeseeable events), as well as fewer scheduled outages (service interruptions needed to carry out certain types of work). In addition, customers would like to see a more stable power supply, since electrical disturbances can affect the operation of some types of equipment, such as computers.

Orientation 3

CONTINUE IMPROVING CONTINUITY OF SERVICE.

Various programs were launched in 1989 to improve the transmission and distribution systems. At the same time, we also created a Maintenance Enhancement Program. Almost $1 billion was spent on these programs from 1990 to 1992.

These efforts have brought results: the average annual interruption time per customer, which includes both power failures and scheduled interruptions, has decreased substantially on all our systems.

But we still have a great deal to do, as shown by the following table, which compares our performance with that of the 14 other members of the Canadian Electrical Association (CEA).

Table 1

Average Annual Interruption Time Per Customer (in hours)

	1989	1991
Hydro-Québec	*14.6* (6.5)*	*6.6 (5.3)*
*Average for 14 other CEA members***	*3.5*	*3.8*

The figures in parentheses are standardized results that exclude exceptional events exceeding the system's design criteria.
* Including the 8.1-hour general power failure that occurred on the transmission system in 1989.
** Data from the CEA annual report.

Our measures affect both the distribution system and generating, transmission and telecommunications facilities. In all cases, we aim to provide a quality product at the lowest possible cost.

Distribution

Equipment defects are a major source of power failures, so we are emphasizing quality-assurance procedures aimed at ensuring that all operations are performed properly the first time, at the lowest cost, and to the customer's complete satisfaction. We will be relying on even higher-quality equipment and greater care in the installation of equipment on our system.

Our response time is a determining factor when a power failure occurs on the distribution system. Given the length and the geographical dispersion of our system, we are trying to automate more of our operations, in particular by accelerating installation of remote-control equipment on the overhead system and its integration into the various automated functions performed by the control centres.

Moreover, to reduce the number of scheduled outages required for construction or maintenance, we will be using remote manipulators that make it possible to work on live equipment.

In urban areas, we will be improving the reliability and flexibility of the underground systems by modernizing their architecture and applying construction criteria recently developed.

Gradual application of new design criteria, especially the installation of series compensation, is substantially increasing the reliability of our transmission system. We must transmit electricity over long distances because of the remote locations of our hydroelectric generating stations. As a result, our transmission system is exposed to various electrical phenomena that can interfere with its proper functioning. Series compensation reduces these effects and thus increases the strength of the system. This project was launched in 1989 and will be completed in 1996.

We will reduce the risk of power failures on the transmission system even further by using higher-quality equipment and maintaining it better, and by having backup facilities at key points on the system. In addition, with the use of automated equipment-behavior-analysis systems, systematic maintenance will gradually give way to maintenance based on need. In general, strategic installations will take priority.

Orientation 4

ENSURE THAT POWER QUALITY FULLY MEETS THE OPERATING REQUIREMENTS OF CUSTOMERS' EQUIPMENT.

Fluctuations in the power supply affect the operation of certain types of equipment in widespread use by our customers, such as computers. This phenomenon is anything but unusual. In fact, it is common to most of the world's electric utilities. One of its effects is production losses for our industrial customers.

We are involved in developing a Canadian protocol for measuring these disturbances, which is essential in order to influence electrical-equipment manufacturers. Moreover, we are closely following the studies which many specialized organizations are conducting in order to establish standards in this area.

At the same time, we intend to pursue the cooperative efforts initiated in 1990 with our industrial customers and partners to reduce or eliminate production losses due to power-supply fluctuations. Corrective measures will be taken to adjust customers' equipment or Hydro-Québec's facilities, as necessary.

2.3 ENVIRONMENTAL AND SOCIAL RESPONSIBILITY

Given the nature and scope of its activities, Hydro-Québec plays a leading role in Québec society. As the province's supplier of electricity, it has important responsibilities to Quebecers and the milieux in which they live. We intend to assume fully our environmental and social responsibilities, which we consider an integral part of our raison d'être.

To this end, we propose to implement a number of orientations concerning public health and safety, as well as protection of the quality of life and the natural environment. Impacts of the construction of new generating facilities are discussed in Chapters 3 and 4. In addition, we will continue to maximize the economic spinoffs of our activities by supporting Québec suppliers in various ways and by encouraging research efforts on the part of other Québec organizations.

Orientation 5

PROTECT PUBLIC HEALTH.

We must ensure that the products used for system operation and maintenance hav no impact on public health or on the environment. We must also sustain research t improve knowledge in certain areas, such as electric and magnetic fields and mercury.

We are striving to reduce environmental risks by managing any substance likely t harm the health of humans, animals or vegetation. Such management usually take place in several stages: identification, removal, treatment (decontamination, elimination, etc.), and storage. We are involved in the PCB-Québec program set up by the ministère de l'Environnement du Québec, which aims to eliminate PCBs from the province. We have already removed almost all PCB-containing equipme from our system and stored it in safe locations that comply with government standards. In the years to come, we will systematically decontaminate products and equipment that formerly contained PCBs.

Irradiated fuel at Gentilly-2 nuclear generating station is stored in a special bay within the plant. The bay has sufficient capacity for storage of irradiated fuel unti 1994. Thereafter, we will need an additional building. To this end, we are completing studies that will be submitted to the Atomic Energy Control Board and the ministère de l'Environnement du Québec.

As for electric and magnetic fields, Hydro-Québec has been conducting studies since 1975 to characterize exposure to these fields and to determine their effects on health. Since 1988 we have also been taking part in an epidemiological study of a large cohort in cooperation with Électricité de France and Ontario Hydro. The results will be known in 1993. We are also involved in laboratory research in cooperation with Health and Welfare Canada, Ontario Hydro, and Institut Armand-Frappier. These studies contribute to the international effort to advance knowledge of the biological effects of electric and magnetic fields.

With respect to fish caught in our reservoirs and the accumulation of mercury in their flesh, we are constantly monitoring changes in mercury levels and the quality of reservoir water. Mercury levels, which are high when reservoirs are created, taper off with time. We are also continuing our research on various topics, including mercury sources, the conversion, transfer and bioaccumulation of mercury, its origin in aquatic and land ecosystems, and how the levels detected have changed over time.

Orientation 6

DO MORE TO PROMOTE SAFETY NEAR OUR FACILITIES.

Each year, members of the public or employees of other companies are exposed to electric shock while doing such work as trimming trees or installing antennas near our facilities.

It is therefore essential that we continue our prevention and awareness efforts. Our communications will be even better targeted and structured, and will focus on safety rules applicable to work carried out close to power lines. Moreover, we will take all appropriate measures to further reduce the time we take to provide assistance to the public.

Orientation 7

PROTECT QUALITY OF LIFE AND THE ENVIRONMENT, AND MANAGE WASTE FROM OPERATIONS MORE EFFECTIVELY.

We are trying to reduce the nuisances caused by some of our facilities, such as transformer noise. We are also striving to ensure that our facilities are visually better integrated with their surroundings. We are already using underground distribution lines in high-density areas for technical and space reasons. In other areas, we use them where municipalities or developers pay the difference between the cost of an overhead and an underground system. This difference is substantial, and we are examining various technical options for reducing it. In addition, we will eliminate the backlog in the construction of underground systems and respond quickly to new requests. Finally, we are conducting a pilot project to further integrate visual and environmental considerations into the construction of overhead distribution lines.

We are stepping up our efforts to limit damage to customer property when our crews work on the distribution system, and to repair such damage promptly if it is unavoidable.

As for management of water bodies, we will continue to proceed on a case-by-case basis, taking the expectations of other users into account. To this end, an inventory of various water-body uses is updated periodically.

We are promoting multiple use of our installations and technological assets. Various decommissioned generating stations, substations and transmission lines have considerable recreational potential, and certain buildings could be used by local communities. We have a number of inventories and studies of our historic installations. We are also promoting multiple use of facilities in service, in cooperation with local communities, when such use is compatible with exploitation of water resources. Some sites could be adapted for new recreational or educational activities and opened to the public.

Management of waste from operations

Our activities produce large quantities of waste: aluminum and copper conductors, transformers, insulating oils, etc. These objects and substances can cause waste or pollution if they are not handled properly.

Management of operating waste is a responsibility we must assume as a utility concerned with both efficient operations and respect for the environment. Our orientation in this area should be based on best current practices. Equipment deemed salvageable will be reused after reconditioning, and substances that can be recycled will go to other industries to be used in their production processes.

In 1993, we intend to develop a comprehensive strategy for managing operating waste on a commercial basis, in partnership with industry. Initially, we will emphasize recycling of non-ferrous metals, especially aluminum and copper, contained in some of our equipment (transformers and power lines).

Orientation 8

Maximize economic spinoffs from our activities.

Hydro-Québec contributes to the province's economic development in several ways. It sustains many jobs through its construction, operating and marketing activities, and it also contributes to Quebec's industrial development. These matters are discussed in Chapters 3 and 4, and in detail in the annex entitled *Contribution to Québec's Economic Development*. The utility also plays an important role through its purchasing policy and its support for research and development.

Our goods-and-services purchasing policy has several thrusts. It first aims to increase the Québec content of our purchases wherever possible, with due regard for quality and cost. It then seeks to determine an adequate number of Québec suppliers in each purchasing category, so as to maintain healthy competition. We also seek to develop closer relationships with our suppliers and to encourage them to keep raising their quality standards. Finally, we encourage Québec suppliers to pursue their R & D efforts and provide us with state-of-the-art equipment that, in turn, will make them more competitive on external markets.

In addition, we will continue to market our know-how abroad, through our subsidiary Hydro-Québec International, and in cooperation with Québec partners.

2.4 HUMAN RESOURCES AND MANAGEMENT

The main strategic advantages of a utility are its know-how and the empowerment of its personnel. This reality creates three major challenges for us. First, we must ensure all our employees embrace the quality culture. Second, we must manage their know-how in optimum fashion. Third, we must give them the means to improve their efficiency on an ongoing basis. To meet these challenges, we have established five long-term orientations.

Orientation 9

ENSURE THAT EMPLOYEES EMBRACE THE QUALITY CULTURE.

It is important that Hydro-Québec continuously improve the quality of its services at the lowest possible cost. Our employees are well aware of this requirement.

Défi performance, launched at the end of 1990, has begun introducing into all the utility's activities the basic principles of total quality management: customer focus, management based on facts, respect for people, and continuous improvement. Almost 100 employee improvement teams are already at work in every region and at head office.

Défi performance has already significantly improved the atmosphere of discussion and cooperation with the unions. But changing mindsets is a long-term undertaking.

The tensions that have long characterized our labor relations have given rise to complex agreements that hinder management of the utility. Establishing relations based on mutual respect, listening and trust between managers and employees is therefore a priority, but one that will require substantial effort by all parties.

We also intend to institute a mechanism for listening to employees. In this way, our planning can better incorporate their views on how to serve customers more effectively.

Orientation 10

ENHANCE THE KNOW-HOW OF OUR EMPLOYEES.

In recent years, Hydro-Québec has intensified its training efforts. Expenditure in this area for all employees was close to $47 million in 1991.

Certain weaknesses are evident, however, in terms of preparing for the next generation of employees. Our training programs have led to such a high degree of mobility, especially in the clerical group, that the utility does not always benefit from the expertise employees acquire during training. We feel that mobility within the company is essential to obtaining maximum benefit from employees' know-how: it should provide them with motivating career paths based on continuous learning. However, it must also enable the utility to benefit fully from the skills acquired by an employee who moves from one position to another. The utility is discussing this matter with the unions to find medium and long-term solutions.

The requirements of most of our positions are evolving in relation to customer needs and technological progress, and the qualifications of the employees who hold these positions must evolve accordingly. We will continue to emphasize internal promotion, while ensuring that employees' qualifications match the requirements of new positions. Thus we will maintain an ongoing inventory of employees' strategic know-how in order to better assess the discrepancies between the utility's needs and the available internal expertise. We will also continue to work with educational establishments to update and improve our employees' basic training and to take account of certain specialization needs.

These efforts will be accompanied by better planning for a new generation of employees in areas where the average age is high.

Orientation 11

IMPLEMENT A MORE EFFICIENT STRUCTURE AND WAY OF MANAGING.

We have undertaken a radical reorganization of our structures. The purpose is to restructure our sectors, regions and head office in line with basic needs by placing decision-making as close as possible to customers. We also intend to reinforce the strategic and technical leadership of the corporate units, to increase the autonomy of operating units, and to increase the accountability of employees who respond directly to customer needs.

In 1990, we divided our operating personnel into two specialized groups: Customers and Distribution, and Generation, Transmission and Telecommunications. Since September 1992, each of the 53 sectors (basic units) in our 10 administrative regions has been specialized and made responsible for one mission. The reorganization affects a total of 18,000 employees.

Furthermore, over the next three years we will reduce the number of regional functional-support positions and increase the number of positions in the sectors directly related to customer needs. The reorganization of the corporate units will be done from the same standpoint. Reorienting corporate and operating roles, as well as the search for greater efficiency in all our activities, implies redeployment of resources and employees throughout the utility. In general, we will constantly adjust the size of our staff to the workload by making comparisons with other efficient utilities.

We will also reorient our management practices, bringing them in line with total quality requirements. Each administrative unit will clearly establish its own customer and supplier relations and work processes. It will also define its quality-assurance procedures, whose purpose is to ensure that all operations are carried out properly the first time, at the lowest cost, and to the customer's complete satisfaction.

We will promote participation, innovation, accountability and teamwork. We will encourage recognition of individual and team performances. We will also ensure that employees in contact with customers have the necessary leeway to meet customer requests.

We will simplify the management of human resources regimes to better support the utility's orientations and strategies.

Orientation 12

IMPROVE OCCUPATIONAL SAFETY.

Despite the occupational-safety progress recorded in recent years, our performance leaves much to be desired. This situation is unsatisfactory for our employees and creates high costs.

We will implement better-targeted prevention programs and will further integrate safety concerns into the design and modification of system components. Lastly, we will adopt safer work techniques for risky work, such as the use of robotics on overhead and underground systems. Our safety efforts will be made in cooperation with the unions.

Orientation 13

ENSURE THAT WOMEN AND MINORITIES ARE BETTER REPRESENTED IN OUR WORKFORCE.

Our current workforce inadequately reflects the overall makeup of Québec's population. Women and members of minorities constitute an underused pool of talent, and they would like to be fully integrated into the economy. Hydro-Québec has made significant progress in the representation of women through specific programs and quantitative objectives supported by management. Still, there is a great deal to be done. Women rose from 19.8% of our permanent staff in 1989 to 21.2% in 1991, and our firm objective is to reach 30% by 1999.

We will gradually extend this approach to Native peoples, ethnic minorities and handicapped persons. We intend to continue integrating Native people into our operations, notably through the existing program to train and hire Cree applicants. As for ethnic minorities and persons with disabilities, we will complete studies on their representation within the utility and their availability on the job market, with a view to putting appropriate hiring measures in place.

2.5 TECHNOLOGY

In order to support its activities and orientations, Hydro-Québec has devoted between 1.7% and 1.9% of its annual sales to research and development (R & D) since 1988, and intends to raise this figure to 2% by the year 2000. For all Québec companies, R & D averages 1.4% to 1.5% of annual sales.

Orientation 14
AIM TO DEVOTE 2% OF OUR ANNUAL SALES TO R & D.

In 1991, Hydro-Québec ranked eighth among Canadian companies in terms of the relative size of its R & D budget. Internationally, it compares well to other large electric utilities, except those in Japan, which invest proportionally almost twice as much as the others in R & D.

R & D IN THE SHORT AND MEDIUM TERM

Short and medium-term research and development accounts for 77% of our R & D activities. Over the next few years, it will focus mainly on continuity of service and power quality, as well as system operation and energy use.

More specifically, our efforts will involve technologies related to energy efficiency and system management tools, the aging of facilities and conditional preventive maintenance, installation planning and design tools, and the design of environmental mitigation measures.

Following is a breakdown of our R & D efforts for 1993-1995:

Service continuity and power quality	29%
System operation	26%
Energy use	17%
Productivity	11%
Environment	11%
Health and safety	6%

Long-term R & D

In the long term, we intend to pursue our R & D activities in the most promising areas, and to conduct studies to facilitate our technological choices.

As regards system operation, two subjects offer interesting long-term potential and are currently the subject of R & D projects: robotics and superconductivity. In the area of long-term electricity supply and demand, our research will focus on solid-polymer electrolyte batteries (ACEP), hydrogen, and nuclear fusion.

Moreover, we will expand the scope of our research and development, giving greater emphasis to work on energy efficiency and concentrating our efforts on the aspects most likely to interest our customers. We will also focus on other means of generation, such as wind turbines and photovoltaic cells.

R & D management

Orientation 15

Encourage networking with industry, universities and research centres.

Hydro-Québec is not alone in assuming the financial risks associated with R & D work on long-term projects; these activities are financed in the range of 50 to 60% by academic, industrial and government partners. This form of collaboration allows Québec, Canadian and even world expertise to crystallize around projects that are of definite interest to the utility.

We will also associate universities, research centres and industries in the development and implementation of new technologies through scientific or industrial partnerships, joint ventures and marketing agreements based on patents or licences, and by the optimum operation of existing subsidiaries. Furthermore, we finance external research projects and university chairs, and provide technological services to our partners.

We must also ensure that new technologies available on the market are identified more efficiently and, at the same time, effectively transferred within the utility.

Marketing technological products

Orientation 16

Intensify the marketing of technological products resulting from our research.

The marketing of technological products arising from our research has developed considerably. This marketing is mainly done by the Nouveler group, a wholly owned subsidiary which invests in existing companies or launches new ones (CYME International, Vibro-Meter, Ultra-Optec, Automatisation Famic, M3I). Nouveler sales have greatly increased over the last few years. The group has made substantial inroads on the international market by marketing products that are recognized as representing the latest technology. This includes software for the management of electrical systems and power failures; systems for the measurement and monitoring of rotating machines; measuring and instrumentation products, and graphic interactive display systems.

We expect Nouveler to continue to expand and foresee that other companies will join the group during the next few years.

We also grant licences to companies in the industrial sector so that they can increase their competitiveness; revenues from these licences greatly increased in 1992. Some 60 Hydro-Québec licences are currently in operation.

2.6 Investments required

To support service-related activities, we intend to spend $19.6 billion in the period between 1993 and 2002.

Table 2

Service-Related Spending — 1993-2002 (billions of dollars)

Distribution	*7.9*
Subtransmission	*3.3*
Power-system improvements	*1.4*
Facility maintenance and replacement	*2.7*
Technology	*0.5*
Other	*3.8*
Total	**19.6**

Electricity Supply and Demand: Long-Term Options

Québec society is facing two major long-term decisions with respect to electricity. On the one hand, it must decide what means to use to continue to meet its electricity requirements. On the other hand, it must decide whether markets for electricity should be developed, and if so, how.

In this section of the Development Plan, the range of options available to Québec in terms of means and markets are presented, in order to fuel discussion and thought about these major issues. The section also includes an analysis of the possible effects of these options and a review of the comments they elicited during the consultation process.

Major decisions about the future of electricity in Québec are of vital importance to our society as a whole. It is essential that these decisions be made with full knowledge of the facts, based on information that is as complete as possible. In order to prepare this document, an initial series of consultations was conducted on possible choices with respect to supply and demand.

This process, which took place in a serene atmosphere, helped create a forum for fruitful discussion. The comments of the participants greatly enriched our understanding and helped define our orientations. Indeed, some of their suggestions will be the subject of analyses that may be used in preparing the next Development Plan. We would like to take this opportunity to thank all the participants for their contribution to this vital dialogue.

3.1 THE MEANS AVAILABLE

To satisfy long-term requirements, a number of means are available to us:

- improving the existing power system;
- promoting energy efficiency;
- replacing electricity with fossil fuels;
- adding new means of generation, including cogeneration.

But before reviewing each of these means, it is important to explain clearly three concepts that are fundamental to this discussion: *economic optimization of means, marginal cost* and *externalities*.

Economic optimization consists in satisfying energy requirements using a combination of means that constitutes the best solution in terms of overall cost.

In this procedure, the basic criterion is the long-term *marginal cost*, i.e. what it costs to meet new demand with new facilities. The final optimization must reflect such factors as all the economic, environmental, social, rate and financial effects of the means used, as well as their risks and the time it would take to execute them.

Evaluation of long-term marginal cost is a complex process. This cost varies with each component of the power system (generation, transmission and distribution) and with each use made of electricity (home heating, industrial process, etc.). The goal is to determine as accurately as possible the cost of satisfying a demand based on all its characteristics.

To achieve economic optimization, the cost of each means available to satisfy electricity requirements must be compared with the appropriate marginal cost. For example, to satisfy residential heating needs, it is possible either to conserve energy or to build new facilities at a cost of 9.2¢/kWh (in 1992 dollars). In this case, economic optimization would consist of opting first for energy-conservation measures by implementing all such measures whose cost is less than or equal to 9.2¢/kWh.

This is a commonly used approach in the electrical industry. However, it raises questions about evaluating the socio-economic and environmental effects, both positive and negative, of generation means. These effects result in costs or benefits for society that are called *externalities*. Examples of negative externalities are atmospheric emissions from thermal generating stations or the flooding of land when a hydroelectric generating station is built; positive externalities would include the economic spinoffs from a project.

Externalities are difficult to quantify. At this time, Hydro-Québec does not include them in its calculation of the marginal cost of generation means. In the United States, however, it is relatively common to assign a credit to energy saved in order to reflect, in calculations, the fact that a specific amount of atmospheric emissions from thermal generating stations has been avoided. This credit varies between 5% and 20%. Renewable forms of energy, such as hydroelectricity, are generally favored over fossil-fuel-based energy technologies.

The matter of externalities was the subject of numerous comments during the Development Plan consultation. Several groups urged Hydro-Québec to begin studies of this issue. Some recommended that the utility begin taking externalities into account immediately, notably in calculating the cost avoided through energy conservation, in analyzing various generation alternatives, and in evaluating different hydroelectric generating projects.

Improvements to the existing power system

Improving the existing power system is one of the means available to satisfy electricity requirements. It consists in increasing the energy yield of generating stations, substations and lines, and usually has very little environmental or social impact. Any possible improvements to our facilities will therefore be carried out wherever the cost is lower than or equal to the marginal cost of new facilities. However, most of this work will be performed as the generating station rehabilitation program progresses. The working document entitled *Improvements to the Power System* details these measures.

Furthermore, there are a number of ways of optimizing the use of the power system by efficiently managing interconnections and exchanges with neighboring systems. The annex entitled *Long-Term Exports and Use of Interconnections* provides further information on this subject.

Some of the groups consulted recommended that all possible improvements to the system be made before other means are used to balance supply and demand.

Energy efficiency

The second means available to meet electricity needs is promoting energy efficiency among our customers. Energy efficiency includes two dimensions: *energy conservation*, which makes it possible to postpone the construction of base-load facilities; and *load management*, which makes it possible to postpone the building of peak-load facilities. (These aspects of energy efficiency are often referred to as demand-side management – DSM.) The annex entitled *Energy Efficiency* explains in detail the various options as well as our analysis and planning methodology.

Energy conservation seeks to provide the same energy service using less electricity. It has a large number of possible applications: household appliances, ventilation, heating and air-conditioning systems for commercial buildings, lighting and industrial motors.

According to our estimates, energy conservation that is technically feasible and less expensive than the marginal cost of the avoided facilities constitutes a potential of 27.6 TWh by the year 2000. Relatively speaking, this potential is lower than that observed in other regions. There are three main reasons for this:

- In the long term, the marginal cost of Québec's hydroelectric power system is at least 30% lower than that of thermal or nuclear systems.

- The heat released by electrical appliances can be useful in a cold climate like Québec's, but this is not necessarily the case elsewhere.

- Because of past efforts in this area, Québec already has a level of electrical efficiency that compares favorably with that of the rest of North America.

In terms of economic spinoffs, energy-conservation measures are comparable to hydroelectric projects: for each million dollars in capital and operating expenditures, they support 11.4 direct and indirect jobs, compared with 10.8 for large hydroelectric projects. Most jobs supported by energy-conservation measures are found in the service sector and are scattered across Québec.

In environmental terms, energy conservation has little impact. Most concerns about the quality of indoor air, the use of insulation products, waste management and product life cycles can be cleared up by taking the appropriate measures.

The execution periods for individual energy-efficiency programs are relatively short, compared to construction projects. However, the implementation of a major comprehensive program requires a systematic approach with customers to ensure that the efforts have lasting effects.

During the Development Plan consultation, one dominant opinion about energy conservation became evident: it is important that Hydro-Québec go as far as possible in this direction, that it step up its activities and make energy conservation a priority. Several groups stressed the need for R & D and development assistance for a specialized Québec industry. Furthermore, a number of participants advocated stronger measures than simply encouraging energy conservation — incentive rates, for instance. Others would like to see regulatory or other measures aimed at reducing or even eliminating growth in electricity demand. Finally, some suggested adding a credit to energy conservation, in comparisons of various options available, to reflect the externalities associated with the generation of electricity.

In order to clarify the discussion on energy efficiency, three possible options for the year 2000 are presented below.

Option A: 9.3 TWh in the year 2000

Option A corresponds to Hydro-Québec's current Energy Efficiency Project. The objective for the year 2000 is 9.3 TWh in energy savings per year (i.e. the equivalent of the electricity currently used by residential customers on the island of Montréal), which means savings of nearly 2,000 MW of peak power. We foresee a whole series of measures with this end in mind: awareness campaigns, commercial and technological support, rate formulas, financial contribution programs, research and development, and activities related to standards and regulation.

Financial assistance is a fundamental element in energy conservation activities. While the measures are clearly cost-effective for society as a whole, this is not always the case for individual customers, at least in the short term. Since rates are below the marginal cost for most uses of electricity, the savings gained by the customer are less than those gained by society.

For these measures to be advantageous for customers, we estimate that Hydro-Québec must assume an average of 60% of the related costs. This kind of contribution will result in increased short-term costs of supply. In the long term, however, the increases will be less than or equal to those that would have resulted from new facilities.

The activities now being planned to achieve Option A are profitable for Québec society, for customers, and for the utility. According to our estimates, the financial resources needed to reach the goal of 9.3 TWh in annual energy savings in the year 2000 amount to $3 billion (constant 1992 dollars) for the period from 1991-2000, $2 billion of which would come from Hydro-Québec.

By their nature, potential energy savings can only be realized over a long period of time. In 2010, we estimate that energy savings will total between 16 and 20 TWh/year, assuming continuity of effort and a certain degree of technological development. For planning purposes, we have retained an average forecast of 18 TWh/year (or 4,000 MW) by the year 2010. Thus, we will have achieved 34% of our initial savings potential by the year 2000, and 65% by 2010.

Many of the participants in the consultation process said they liked this option, but still want Hydro-Québec to make every effort, creatively and even aggressively, to promote energy conservation.

Option B: 4.3 TWh in the year 2000

Under Option B, all energy-conservation measures with costs lower than the marginal cost are taken into account. However, the aim is to contribute financially only to those energy-conservation measures that are cost-effective with respect to Hydro-Québec's revenues and expenses. Such an approach would minimize the short-term impact on costs of supply, but would result in a more substantial increase in the long term. With this option, we would not finance energy-efficiency programs for certain uses where rates are higher than marginal cost. Also, in many cases, our financial contribution would not be sufficient to allow our customer programs to penetrate significantly.

The groups consulted did not look favorably upon this option, mainly because it would require more new generating facilities than Option A.

Option C: 10.2 TWh in the year 2000

Under Option C, Hydro-Québec would choose energy-conservation measures based on the avoided cost plus 30%. The avoided cost plus 30% corresponds to the marginal cost of a system based on thermal generation. As a result, the cost advantage of hydroelectric power is not taken into account here.

Additional energy savings would be fairly limited, however, since the new measures resulting from the increase in avoided costs are much more expensive. Their cost-effectiveness for the customer would be significantly lower than that of the measures now being considered, and Hydro-Québec's financial contribution would have to increase to approximately 75%. We estimate the additional annual energy savings at 0.9 TWh by the year 2000 and at 1.8 TWh in 2010. This option would involve an increase in costs of supply in the short and long term.

Some of the groups that were consulted see this option as a good way of increasing the value of energy savings to take the externalities of power generation projects into account.

Replacing electricity with fossil fuels (fuel switching)

Some utilities, such as Ontario Hydro, plan to satisfy the demand for electricity by encouraging their customers to use fossil fuels to replace electricity. If Hydro-Québec had to increase its base-load thermal generation permanently to meet the growth in demand, it would be attractive, from technical, economic and environmental points of view, to promote this type of substitution. For electric heating, for example, it would be better to replace thermal generation, which has an overall energy yield of only 45%, with direct combustion in the customer's home, where the yield should reach 80% with efficient systems. This is why we have already implemented a number of replacement programs in our off-grid systems, such as the Îles de la Madeleine. However, with a hydroelectric system, this reasoning does not hold true.

Given the marked preference of Québec customers for electric heating, it is not very likely that substitution programs will, in the long term, lead to a widespread shift to fuels. The principal markets where promoting fuels might be considered, given the costs and hence economic profitability, are the new heating markets (upcoming conversions and new buildings) and dual-energy markets.

In general, the groups felt that promoting fuels to replace electricity was not a very desirable option because of the atmospheric pollution this would cause.

Adding generation options

Adding generation is another way of satisfying electricity requirements. The following pages deal with hydroelectric, thermal and nuclear options, as well as new sources of energy. The annex entitled *Means of Generation* explains the options and their features in detail.

In large river systems such as Grande Baleine and Nottaway-Broadback-Rupert (NBR), along with other smaller sites like Sainte-Marguerite, Haut-Saint-Maurice and Ashuapmushuan, Québec has an economically viable potential of 18,600 MW or 100 TWh. Moreover, the possible future development of generating stations on the Lower Churchill could mean purchases of approximately 2,500 MW. Finally, from a strictly technical point of view, there is a potential of approximately 7,000 MW from Québec's medium-sized and small rivers, the economic viability of which still remains to be seen.

Most of the generating stations require the creation of reservoirs to regulate the natural flow of water where they are located. By storing water, the reservoirs make it possible to produce electricity according to need rather than according to water inflows. Without reservoirs, thermal stations would have to be built to meet peak demand in winter and to protect against periods of low runoff. Hence, reservoirs play a dual role: they ensure an annual reserve, that is, store water when levels are high to produce electricity during the winter, and they ensure an interannual reserve, that is, store water in years when the runoff is heavy to produce electricity during years when the runoff is low.

Hydroelectricity is the least expensive means of generation in Québec. The cost of future large hydroelectric generating stations ranges from 3.5 to 4.6¢/kWh (in 1992 dollars). By its very nature, this type of energy involves sizable capital outlays. On the other hand, its operating costs are much lower than for any other means of generation.

Given its degree of integration into Québec's economic structure, hydroelectricity is the means of generation that produces the most economic spinoffs: approximately 11 direct and indirect jobs are sustained for each million dollars in capital and operating expenditure. Jobs sustained by the hydroelectric option are mainly in the construction sector, necessarily concentrated at project sites, and in the electrical equipment manufacturing sector.

Hydroelectric developments and the resulting transmission of electricity have environmental and social effects. Although the facilities are designed to reduce these effects and many mitigative measures have been implemented, some effects cannot be avoided, for example, the flooding of lands, the temporary increase in mercury in reservoirs, and the installation of large transmission lines. On the other hand, the hydroelectric option uses a renewable resource and produces virtually no atmospheric emissions.

Because of the distances involved, the hydroelectric option requires long transmission lines. However, expanding the use of series compensation will make it possible, in the future, to substantially limit the number of additional lines.

In general, the hydroelectric option is not very flexible, especially in the case of large projects. These projects provide power and energy in large blocks, the construction periods are relatively long (decisions must be made approximately eight years before a facility is commissioned), and the process of obtaining authorization and permits takes several years.

The hydroelectric option was strongly supported by the groups consulted because it uses a renewable resource. Some groups suggested that Hydro-Québec study the externalities more thoroughly in order to improve the comparison between generation options. Others were interested in more detailed studies of the small and medium-sized rivers. Finally, still others recommended a comprehensive ranking of all the rivers in Québec.

The thermal option

The thermal option, which is based on proven technology, includes conventional thermal stations, combined-cycle stations and cogeneration plants. The fuels used are natural gas, fuel oil, biomass, waste, coal, etc. In neighboring systems, most of the development projects are based on this option.

For peak or reserve generating facilities, fuel oil has an advantage in that it can be stored. As a base option, natural gas would be the fuel of choice for Hydro-Québec as for all North American electric utilities because of its price and availability and because it has less environmental impact than other fuels.

The long-term costs for the thermal option are clearly higher than for hydroelectricity: we estimate that the difference could reach nearly 50%, given a median forecast increase in natural gas prices. However, the price of natural gas varies a great deal. Since, at present, it is low, the cost difference between the thermal option and the hydroelectric option is closer to 10%. This difference is calculated according to 20-year supply contracts signed at current prices and then adjusted for general inflation.

Compared with the other options, the investments involved in a thermal option are not as substantial, but operating costs are very high, mainly because of the price of fuels. In addition, the thermal option creates approximately four direct and indirect jobs per million dollars in capital and operating expenditure — fewer than any other generating option.

The main environmental effects of the thermal option are the production of atmospheric emissions, especially greenhouse gases, and the use of non-renewable resources. On the other hand, thermal generating stations do not require much space and can be built near load centres, which means that long transmission lines do not have to be built. However, such stations may require the installation of gas pipelines and may present certain health risks to people who live nearby.

The thermal option is relatively flexible: generating capacity can be adjusted according to needs, and the time required for implementation is only about five years. It could be used as the principal generating option or as a backup source. In both cases, it would be good to use it in a flexible manner, namely as a means of optimizing the management of hydroelectric facilities, which are subject to variations in runoff.

Cogeneration is an interesting variant of the thermal option. Its thermal efficiency is between 50% and 80%, while the efficiency of generating stations that produce only electricity does not exceed 50%. The difference stems from the fact that, in the case of cogeneration, waste heat is transformed into steam that can be used by an industrial plant adjoining the station.

According to current data, cogeneration creates only four direct and indirect jobs per million dollars of capital and operating expenditure. However, it has many advantages for industries: integration with industrial processes, reduction of input costs, elimination of industrial waste. It allows companies to lower their energy costs and, as a result, makes them more competitive.

Among the groups consulted, the idea of using thermal generation as the principal option was not very popular. However, the idea of cogeneration was deemed interesting provided the environmental effects were acceptable. Some participants did, however, express reservations about this option because it does not generate much in the way of economic spinoffs for Québec.

The nuclear option

Nuclear energy is a proven technology and is used throughout the industrialized world. Hydro-Québec already uses Canadian-designed CANDU technology in its Gentilly-2 plant. The nuclear industry is very strict where safety and environmental protection are concerned, and it continues to place a lot of emphasis on R & D, especially in the area of safety.

For technical and economic reasons, nuclear power plants work on a continuous basis. Thus, they constitute a base option and must be supplemented with peaking equipment to adjust to fluctuating demand.

Nuclear plants are capital-intensive, but operating costs are lower than for the conventional thermal option. If we compare unit costs on an equivalent basis, nuclear costs 40% more than the hydroelectric option.

The nuclear option creates close to nine jobs per million dollars of capital and operating expenditure. Jobs related to the operation of nuclear power plants require very highly skilled workers.

In terms of the environment, nuclear generation does not produce atmospheric emissions. However, the irradiated fuel must be stored for a long time. For the moment, storage on nuclear sites is satisfactory, but studies are being done to find a permanent storage method. Nuclear plants take up very little space and can be located near load centres, thus eliminating the need for long transmission lines. On the other hand, public perception of the risk of a nuclear accident is a major obstacle.

This option is not very flexible: output cannot be varied and the period required for implementation is very long, that is, between 10 and 12 years.

In general, the groups consulted were not enthusiastic about the nuclear option. A few said they were firmly opposed to it. However, others suggested that Hydro-Québec maintain a minimum of technical expertise in case recourse to this option becomes necessary.

Alternative energy sources

Among the alternative sources of generation, wind energy seems to be the most interesting long-term option for Québec because of its availability and its cost. In comparison, solar energy is a much more expensive means of generation and its availability does not correspond with Québec's requirements.

The wind option has made great strides in Europe and in California where, over the past 10 years, it has become more reliable and cost-effective. At the technical level, it is now a mature option.

In Québec, there are a few areas that have potential with regard to developing this option, but most of them are located on the periphery of the main system.

Integrating the wind option into the main system does not seem to be economically attractive. The cost of producing wind energy is between 6 and 7.5¢/kWh (in 1992 dollars), depending on the site and the number of units. But if we calculate the cost of equivalent service, that is, taking into account the equipment necessary to firm up power, the cost increases to 8.5¢/kWh, much higher than the price of new hydroelectric facilities, which ranges from 3.5 to 4.6¢/kWh. Wind power is best used in thermal power systems, since it results in fuel savings. In Québec, isolated off-grid systems might be interesting sites for the wind option, as much for the costs involved as for the wind potential. Wind power creates about seven direct or indirect jobs per million dollars of capital and operating expenditure.

Most of the groups consulted would like Hydro-Québec to explore the renewable options more deeply and to diversify its means of generation. Many of the participants encouraged the utility to further focus on wind energy by, for example, operating wind turbines as a demonstration project.

3.1.1 Analyzing supply option combinations

Some options are more attractive than others because of their flexibility and their technical, economic and environmental characteristics. Given the reactions they elicited during public consultation, we have retained the following options for analysis and discussion purposes: energy conservation according to Option A (9.3 TWh in the year 2000) and Option C (10.2 TWh in the year 2000); hydroelectric generation; the thermal option and the wind option (1,000 MW). Note that all the combinations analyzed include 760 MW of purchases from independent power producers (IPPs) who operate small hydroelectric stations, from generating stations that use biomass and waste, and from cogeneration plants. Two additional cogeneration options were also examined: one for an additional 440 MW and the other for an additional 740 MW.

The purpose of this section is to compare the various option combinations that would satisfy the same electricity requirements. A working document entitled *Combinations of Options — Impacts* gives detailed results of these comparisons. Another working document, *Combinations of Options — Methodology for Impact Analysis*, gives details on our methodology.

Our analysis deals with the following five combinations of options:

	Energy conservation	Additional cogeneration	Hydroelectric generation	Thermal generation	Wind generation
Comb. 1	*9.3 TWh in the year 2000*		*Added starting in 1997*		
Comb. 2	*9.3 TWh in the year 2000*	*440 MW in 1998*	*Added starting in 1999*		
Comb. 3	*10.2 TWh in the year 2000*		*Added starting in 1997*		
Comb. 4	*10.2 TWh in the year 2000*	*740 MW in 1998*		*Combined-cycle power stations starting in 2001*	
Comb. 5	*10.2 TWh in the year 2000*		*Added starting in 1998*		*1,000 MW in the year 2000*

The main economic, rate and financial impacts of the option combinations are indicated in Table 3, and the main environmental impacts are shown in Table 4. Highlights of these impacts are presented in the following pages.

Table 3

Main Impacts of Supply Option Combinations

Requirements Before Utility Intervention

	Combination 1	**Combination 2**	**Combination 3**	**Combination 4**	**Combination 5**
Energy savings	*9.3 TWh*	*9.3 TWh*	*10.2 TWh*	*10.2 TWh*	*10.2 TWh*
Additional cogeneration		*440 MW*		*740 MW*	
Generating option	*Hydroelectric*	*Hydroelectric*	*Hydroelectric*	*Thermal*	*Wind (1,000 MW)* *Hydroelectric*
Total cost to Hydro-Québec and its customers ($ billion discounted to 1992)	*37.1*	*37.5*	*37.4*	*41.6*	*38.7*
*Comparative cost index **	*1.0*	*1.30*	*1.27*	*1.44*	*1.74*
Average annual difference in costs of supply, 1996-2010 (1992 $ million)*	**	*40*	*75*	*90*	*100*
*Hydro-Québec investments 1996-2010*** (1992 $ billion)*	*44.7*	*43.7*	*43.6*	*36.3*	*46.1*
Hydro-Québec's overall profit margin, 1996-2010 (%)	*13.1*	*12.8*	*12.9*	*10.6*	*12.8*
*Jobs sustained by total investments, 1996-2010*** (in person-years)*	*456,000*	*448,900*	*459,400*	*361,700*	*466,600*
Tax benefits for Québec, 1996-2100*** ($ million discounted to 1992)*	—	*(100)*	*(65)*	*(605)*	*(40)*

* Refers to Combination 1.

**In Combination 1, rates increase at an annual average of 3.5% from 1996 to 2010, i.e. at the long-term rate of inflation forecast by Hydro-Québec.

***Adjustments have been made to take into account the variation, for the different combinations, in forecast investments for the 1993-1995 period.

Table 4

Main Environmental Impacts of the Various Supply Option Combinations

Requirements Before Utility Intervention

	Combination 1	**Combination 2**	**Combination 3**	**Combination 4**	**Combination 5**
Energy savings	*9.3 TWh*	*9.3 TWh*	*10.2 TWh*	*10.2 TWh*	*10.2 TWh*
Additional cogeneration		*440 MW*		*740 MW*	
Generating option	*Hydroelectric*	*Hydroelectric*	*Hydroelectric*	*Thermal*	*Wind (1,000 MW)* *Hydroelectric*
Surface area required in 2010 (square kilometres)	*5,150*	*5,150*	*5,150*	*Negligible*	*5,400*
Land flooded in 2010 (square kilometres)	*2,200*	*2,200*	*2,200*	—	*2,200*
Total atmospheric emissions in Québec in 2010 (thousands of tonnes)					
SO_2	*0.1*	*0.2*	*0.1*	*0.3*	*0.1*
NO_x	*3.9*	*8.0*	*3.9*	*13.8*	*3.9*
CO_2	*3,655*	*6,880*	*3,655*	*13,300*	*3,655*
Main issues					
Perceptions and social changes (main characteristics)	*Changes in lifestyle of affected communities*	*Changes in lifestyle of affected communities*	*Changes in lifestyle of affected communities*	*Pollution* *Risk of accident*	*Noise and visual impact* *Changes in lifestyle of affected communities*
Water, air and soil quality (main characteristics)	*Methylmercury*	*Methylmercury* *Atmospheric pollution* *Thermal waste*	*Methylmercury*	*Atmospheric pollution* *Thermal waste*	*Methylmercury*
Occupation and organization of the territory (main factors)	*Transmission lines* *Opening up of remote areas*	*Transmission lines* *Opening up of remote areas* *Fuel transport*	*Transmission lines* *Opening up of remote areas*	*Fuel transport*	*Transmission lines* *Opening up of remote areas*
Natural ecosystems (main factors)	*Creation of aquatic habitats at the expense of land habitats*	*Atmospheric pollution* *Thermal waste*	*Creation of aquatic habitats at the expense of land habitats*	*Atmospheric pollution* *Thermal waste*	*Creation of aquatic habitats at the expense of land habitats*

The total cost indicator for Hydro-Québec and its customers includes all the costs forecast for generation, transmission and distribution facilities, independent (IPP) generation purchasing costs, and the cost of energy-conservation measures, until infinity. Cash flows are all discounted to 1992, and are comparable.

Combination 1 is the most economical, at $37.1 billion, and Combination 4 is the most costly, at $41.6 billion. Combinations 2, 3 and 5 are somewhere in between (see Table 3). The comparative cost index gives a better idea of the differences among the various combinations by comparing only those factors that set them apart. Thus, the comparative costs of Combinations 2 and 3 are approximately 30% higher than those of Combination 1 while, for Combination 5, the difference is close to 75%.

In Combination 1, electricity rate increases are aligned with the rate of inflation forecast for 1996 to 2010. To illustrate the impact of the other combinations on the progression of costs of supply, we have used an indicator that represents the average annual difference in costs of supply, in millions of 1992 dollars, in relation to Combination 1. Combinations 3, 4 and 5 have differences ranging from $75 million to $100 million dollars per year. Thus, with these combinations, costs of supply would exceed those of Combination 1 by approximately 1% per year. In the case of Combination 2, costs of supply would be an average of 0.5% higher per year than for Combination 1.

Hydro-Québec's investments include all the amounts required to implement a combination: energy efficiency, facilities for generation, transmission, subtransmission and distribution, etc. Combination 4 clearly stands out from the rest with investments of over $36 billion, that is, $7 billion to $10 billion less than the others.

The utility's overall profit margin is defined as the ratio, given as a percentage, of net income to total revenue. Approximately the same profit margin, that is, between 12.8% and 13.1%, is obtained for Combinations 1, 2, 3 and 5. The profit margin for Combination 4, at 10.6%, is the lowest because of lower investments and higher operating costs.

The number of direct and indirect jobs was calculated taking into account all the investments required in a combination, that is, Hydro-Québec's investments, those of the cogenerators and those of utility customers, in the case of energy conservation. With Combination 1, some 456,000 jobs would be sustained between 1996 and 2010. The greatest difference is in Combination 4, where there are about 95,000 fewer. Combination 5 is the best in this regard, with nearly 467,000 jobs sustained.

Tax benefits for Québec amount to $2.7 billion between 1996 and 2010 for Combination 1, and $600 million less for Combination 4. Combinations 2, 3 and 5 would also generate less tax revenue.

Table 4 gives the key environmental issues related to the five combinations, as well as the quantifiable impacts, namely the surface area required, land flooded and amount of atmospheric emissions.

Combination 4, which is based on thermal generation, is clearly in a different class from the rest in this respect. The environmental issues related to it are of a completely different nature and involve mainly atmospheric emissions. There is an increase of 6% in nitrogen oxide (NO_x) emissions forecast for 2010 over the total emissions observed in Québec in 1990. Carbon dioxide (CO_2) emissions amount to 13.3 million tonnes, an increase of close to 13% over the 1990 level. One of the environmental advantages of Combination 4 is that it requires very little surface area compared with the others.

The other combinations differ little, with the exception of Combination 2, where the atmospheric emissions are higher because of additional cogeneration.

3.1.2 Means of meeting capacity requirements

Any power system must meet both energy and capacity requirements. Energy conservation and base-load generating stations take care of most of the annual capacity requirements. Peak winter demand can be met through load manageme additional capacity at some hydroelectric power stations, installation of gas turbi or purchases from neighboring systems.

Possible means of managing load have very different features. On the one hand, interruptible power and the use of emergency generators on customers' premises can only be used a few hours a year because of their economic characteristics or constraints they impose on customers. There is a net benefit to using existing emergency generators rather than gas turbines, which take three to five years to build. Interruptible power is dependent on industrial development projects and other unforeseeable factors; consequently, it provides less flexibility for planning.

Dual-energy systems and seasonal rates, on the other hand, are likely to reduce demand for relatively long periods and can serve as a partial substitute for additional capacity. Dual-energy systems take two to four years to implement, making them attractive in terms of flexibility. However, potential quantities are relatively low, since the intention is to target very specific market segments so as not to boost the demand for electric energy.

Time-of-use rates will be studied in various pilot projects, to clarify their potentia and limitations. The annex entitled *Long-Term Rate Orientations* provides specific details on this subject.

Finally, additional capacity requires construction lead times of about five years. Such facilities are attractive in terms of cost, but add little flexibility to planning.

During consultation, several groups suggested that we make greater use of load management to meet capacity requirements.

3.2 Market development

The advantages of hydroelectricity make it possible to develop three distinct markets: electrotechnologies, electro-intensive industries and exports.

Electrotechnologies

Electrotechnologies are electrical processes that can replace traditional, generally fuel-based industrial processes. These technologies, not yet widespread but being rapidly refined, include microwave, plasma and various chemical processes. The potential clientele is mainly small and medium-sized industries, where electricity is not a major factor in production costs.

We have been supporting the development of electrotechnologies through implementation assistance programs dating back to 1983, and through R & D activities at the electrochemical and electrotechnology research laboratory (LTEE) and at Hydro-Québec's research institute (IREQ).

Electrotechnologies make industry more competitive by reducing costs through more efficient use of energy. In many cases, they also contribute to improved product quality. The annex entitled *Contribution to Québec's Economic Development* provides more information on this subject.

Based on current technological prospects, it is estimated that this market will represent an addition of about 0.6 TWh in the year 2000 and 1.3 TWh or 220 MW in 2010. Hence, development of the electrotechnology market would require implementation of some additional means, but no large-scale effort.

In general, participants in the consultation favored the development of electrotechnologies, given their positive effects on industry.

The main impacts of electrotechnologies in relation to Combination 1 are shown in Table 5. They include a certain net economic benefit for Hydro-Québec, a slight increase in jobs sustained and an increase of $85 million in tax revenues. Their effect on cost of supply and on Hydro-Québec investments and profits is marginal.

Electro-intensive industries

Electro-intensive industries — smelting, refining, and industries that use electrochemical processes — largely base their choice of location on the availability and price of electricity. Hydro-Québec is in a position to make business proposals which could encourage these industries to expand their plants or undertake new long-term projects. One possible option involves 180 MW or 1.5 TWh, the other involves 540 MW or 4.5 TWh. This subject is discussed in more detail in the annex entitled *Contribution to Québec's Economic Development*.

The question of electro-intensive industries gave rise to many comments during consultation. Several groups argued that contracts with specific companies should be in the public domain and that Hydro-Québec should recover the normal rate applied to this type of customer. Some also pointed out that more efforts should be made to encourage secondary processing of products in Québec.

If the 180 MW option is combined with development of electrotechnologies, the following impacts are obtained in relation to Combination 1: slightly negative overall net economic benefit for Hydro-Québec, an average annual variance of $25 million in cost of supply, a greater number of jobs sustained and $210 million in additional tax revenues for Québec (see Table 5). Taken by itself, the 180 MW option for electro-intensive industries would have a negative effect on Hydro-Québec's net benefit picture and a small impact on cost of supply. However, this is not unusual because new markets in Québec are always developed at a marginal cost higher than the average rate.

When electrotechnologies are combined with the 540 MW option for electro-intensive industries, we obtain the following impacts in relation to Combination 1: strongly negative net economic benefit for Hydro-Québec, an average annual increase of $85 million in cost of supply, a greater number of jobs sustained and $465 million in additional tax revenues for Québec. The most significant environmental impact of this combination is an increase in air pollution and solid waste. These impacts are detailed in Tables 5 and 6.

Exports

Hydro-Québec and its neighbors are linked by major interconnections with a capacity of about 6,000 MW. This capacity plays a very important role in sales of surplus electricity in periods of heavy runoff or weak demand, as well as in purchases of electricity and sharing of reserves with neighboring systems in times of need. Moreover, after taking account of interconnection requirements for signed export contracts, the existing capacity allows for other exchanges on a firm basis.

Since the publication of the 1990-1992 Development Plan, the long-term sales outlook has changed considerably. As a result of the recession and the intensive application of energy-conservation measures, neighboring systems have reassessed their situation. Overall, they will only need new sources of supply after the year 2000.

The present climate therefore is not favorable to the signing of major contracts, especially since competition is very strong, particularly from independent power producers using low-priced natural gas. Nevertheless, limited regional needs can be foreseen for neighboring systems by the late 1990s. We could consolidate our position in export markets by responding to some of those needs.

In the longer term, sales possibilities in export markets will depend on the evolution of needs in neighboring systems and the utility's competitive position in these markets. It is anticipated that neighboring systems will have major demand requirements after the year 2000. It is also likely that the relative price of natural gas will increase. However, to meet part of these needs, Hydro-Québec will have to strengthen its market position by offering a product that is more in line with customer expectations.

Our studies indicate that the export market will develop gradually and will reach 1,500 MW by the year 2004. By this date, Hydro-Québec may also be in a position to deliver hydroelectric power. This scenario has therefore been selected for analysis of market development options. The question of exports is discussed in greater depth in the annex entitled *Long-Term Exports and Use of Interconnections*.

The groups consulted generally had a fairly favorable reaction to exports, but on certain conditions. For example, export quantities should be limited, their profitability should be assured, the risks assumed by the utility should be minimized, and environmental and social impacts — both in Québec and in neighboring systems — should be taken into consideration.

When export sales, electrotechnology development and the 180 MW option for electro-intensive industries are all combined, the impacts, compared to Combination 1, can be summarized as follows (see Tables 5 and 6): substantial overall net economic benefit for Hydro-Québec, no negative effect on the cost of supply attributable to exports, the largest number of jobs sustained of any of the combinations analyzed, more than $535 million in tax revenues for Québec, and an increase in the utility's profit margin. The major environmental impact of this combination is that effects from the construction of generating facilities in Québec would occur earlier, and atmospheric emissions in neighboring systems would be reduced.

Table 5

Main Impacts of Market Development Options

	Combination 1 *Without market development*	**Combination 1A** *Electrotechnologies*	**Combination 1B** *Electrotechnologies Industries (180 MW)*	**Combination 1C** *Electrotechnologies Industries (540 MW)*	**Combination 1D** *Electrotechnologies Industries (180 MW) Exports (1,500 MW)*
Global net benefits for Hydro-Québec ($ million discounted to 1992)*	—	75	(70)	(540)	835
*Benefit/cost index**	1.0	1.07	0.96	0.82	> 1
Average annual variance in costs of supply, 1996-2010 (1992 $ million)*	**	(5)	25	85	25
*Hydro-Québec investments, 1996-2010*** (1992 $ billion)*	44.7	45.0	45.6	46.2	50.9
Hydro-Québec's overall profit margin, 1996-2010 (%)	13.1	13.2	13.1	12.3	13.7
*Jobs sustained by total investments, 1996-2010*** (person-years)*	456,000	462,900	475,200	493,900	531,000
Tax benefits for Québec, 1996-2010** ($ million discounted to 1992)*	—	85	210	465	535

* Relative to Combination 1.

**In Combination 1, rates increase at an annual average of 3.9% from 1996 to 2010, i.e. at the long-term rate of inflation forecast by Hydro-Québec.

***Adjustments have been made to take into account the variation, for the different combinations, in forecast investments for the 1993-1995 period.

Table 6

Main Environmental Impacts of Market Development Options

	Combination 1 *Without market development*	**Combination 1A** *Electrotechnologies*	**Combination 1B** *Electrotechnologies Industries (180 MW)*	**Combination 1C** *Electrotechnologies Industries (540 MW)*	**Combination 1D** *Electrotechnologies Industries (180 MW) Exports (1,500 MW)*
Surface area required in 2010 (square kilometres)	5,150	5,150	5,710	6,250	6,975
Land flooded in 2010 (square kilometres)	2,200	2,200	2,340	2,490	3,635
Total atmospheric emissions in Québec in 2010 (thousands of tonnes)					
SO_2	0.1	0.1	0.1	0.1	0.1
NO_x	3.9	3.9	3.9	5.7	3.9
CO_2	3,655	3,655	3,670	5,050	3,800
Atmospheric emissions avoided in neighboring systems in 2010 (thousands of tonnes)					
SO_2					4.2
NO_x					3.4
CO_2					7,415
Main issues					
Perceptions and social changes (main characteristics)	*Changes in lifestyle of affected communities*	*Changes in lifestyle of affected communities*	*Changes in lifestyle of affected communities*	*Changes in lifestyle of affected communities*	*Changes in lifestyle of affected communities*
Water, air and soil quality (main characteristics)	*Methylmercury*	*Methylmercury*	*Methylmercury Atmospheric pollution Solid wastes*	*Methylmercury Atmospheric pollution Solid wastes*	*Methylmercury Reduction of greenhouse gases (US)*
Occupation and organization of the territory (main factors)	*Transmission lines Opening up of remote areas*	*Transmission lines Opening up of remote areas*	*Transmission lines Opening up of remote areas*	*Transmission lines Opening up of remote areas*	*Transmission lines Opening up of remote areas*
Natural ecosystems (main factors)	*Creation of aquatic habitats at the expense of land habitats*	*Creation of aquatic habitats at the expense of land habitats*	*Creation of aquatic habitats at the expense of land habitats*	*Creation of aquatic habitats at the expense of land habitats*	*Creation of aquatic habitats at the expense of land habitats*
			Environmental changes associated with forestry and mining operations	*Environmental changes associated with forestry and mining operations*	*Environmental changes associated with forestry and mining operations*

Electricity Supply and Demand: Proposed Orientations

4

As a public utility, Hydro-Québec's role is to propose orientations it finds most beneficial for its customers and for society as a whole, in terms of both meeting future electricity demand and developing markets.

We therefore analyzed the impacts of the options outlined in Chapter 3 according to a number of criteria we considered important. Net economic benefits for Hydro-Québec and our customers, adhering to the principle of sustainable development, and supplying services at the best possible cost are some of these criteria, as are maintaining the utility's financial health, sustaining jobs in Québec and ensuring a margin of flexibility in planning. Energy and power reliability must also be maintained so as to guarantee continuity of service.

All the orientations proposed in this chapter for maintaining a long-term balance between electricity supply and demand will require decisions by 1995. The last section of the chapter evaluates the effect of the proposed orientations on changes in overall electricity demand, specifies the dates by which decisions must be made to ensure demand is met, and shows the investments required up to the year 2002.

4.1 THE MEANS

To meet future electricity requirements, priority will be given to improving the existing system and to energy conservation in all cases where the cost of such measures, for equivalent service, is less than or equal to the cost of new generating facilities. These two solutions fully meet Hydro-Québec's criteria and have no significant environmental impacts. The addition of new generating facilities ranks only third as a priority.

Orientation 17

GIVE PRIORITY TO IMPROVING THE EXISTING SYSTEM AND TO ENERGY CONSERVATION.

Improving the existing system does not require long-term strategic choices. Altogether, the improvement measures planned should provide a gain of 2 TWh by the year 2000.

Energy conservation

Hydro-Québec has always assisted its customers in using electricity efficiently. In the past two years, however, we have stepped up our efforts through such measures as promoting customer awareness, commercial and technical support, special rate formulas, financial assistance programs, research and development, and regulatory actions. Our objective is to encourage all energy-saving measures that cost less than the marginal cost of supplying electricity.

Orientation 18

CONTINUE TO TARGET ANNUAL ENERGY SAVINGS OF 9.3 TWH IN THE YEAR 2000.

Our energy-conservation target is comparable to those of the most progressive utilities. It is ambitious, but realistic. Over the next few years, results will be closely evaluated and adjustments made as necessary.

This orientation will involve working in partnership with all parties within the framework of the Québec government's energy-efficiency strategy. We are also committed to fostering the emergence of a competitive Québec industry specializing in energy efficiency.

To make the 10.2 TWh option a concrete reality in the year 2000, we would have to take measures which are currently uneconomic. We believe that such action would be premature, and that it would be better to focus on the considerable range of measures with assured net benefits.

Moreover, to surpass the options presented would require sharp rate hikes or very severe energy-efficiency regulations, which would involve substantial additional costs. At present, there is no reason to think that our customers, on the whole, are inclined to choose such an approach.

Means of generation

Despite energy-efficiency measures and improvements to the existing power system, new generation will be required to meet forecast demand between now and the year 2010.

It is important to distinguish between two main types of generation means: principal and backup. The principal option must be based on proven technology and must be available for large-scale continuous use. Backup generation is divided into two sub-categories. The first offers fewer benefits than principal generation, but can nonetheless play a significant role in a diversified generating system. The second sub-category consists of facilities with intrinsic characteristics that limit their use.

PRINCIPAL GENERATION

Orientation 19
GIVE PRIORITY TO HYDROELECTRICITY, INCLUDING SMALL FACILITIES OPERATED BY INDEPENDENT PRODUCERS, FOR PRINCIPAL GENERATION.

Of all the options studied, hydroelectricity and certain gas-fired thermal plants (particularly cogeneration or combined-cycle plants) emerge as the most attractive. Hydroelectric stations are divided into three categories: large, medium and small. Those built on large rivers are the backbone of principal generation. Medium-sized facilities are discussed below, in the section on backup generation. As for small hydroelectric stations, we favor proposals from independent power producers (IPPs) for plants generating less than 25 MW and offering a purchase price comparable to the avoided cost of facilities in our system. Several of these proposals are the result of the development program for small hydroelectric generating stations sponsored by the ministère de l'Énergie et des Ressources du Québec.

The nuclear option has not been retained. In addition to being much more costly and requiring longer construction lead times than the hydroelectric option, it is generally not well perceived by public opinion.

Hydroelectricity and gas-fired thermal generation have very different features. Hydroelectric facilities require substantial capital and relatively long lead times of five to eight years, depending on the project. Gas-fired thermal stations have significant variable costs and short construction periods (about three years).

The relative net economic benefits of the hydroelectric option are lower than in the past. Because hydroelectric plants require major capital investments, this energy source has suffered in recent years from the high cost of capital. At the same time, the current low price of natural gas gives an advantage to gas-fired thermal generation. But it is far from certain that this situation will continue over the long term, given the considerable uncertainty surrounding natural gas prices.

Hydroelectricity offers the best guarantee of minimum long-term changes in costs of supply. Rates may, however, be slightly higher in the first few years after facilities are commissioned.

Hydroelectric generation respects the principles of sustainable development. However, it produces environmental and social impacts which require mitigative measures. Thermal generation raises two major concerns: atmospheric emissions and the use of non-renewable resources.

From an economic standpoint, hydroelectricity will ensure the most spinoffs in Québec. Hydro-Québec is at the heart of a major industrial cluster and is committed to strengthening and developing Québec's electrical industry.

Hydroelectricity is less advantageous than other options in terms of lead times needed for authorization and construction. However, its flexibility could be increased by establishing a bank of projects for which the draft-design studies and environmental assessments would already have been completed.

Orientation 20

WORK WITH COMMUNITIES AFFECTED BY HYDROELECTRIC PROJECTS.

To find the best ways to mitigate the environmental and social impacts of hydroelectric projects, it is essential to work with the communities affected by such developments.

Up until now, Hydro-Québec has made funds available to communities affected by our generating and transmission line projects. These funds have been earmarked for environmental enhancement initiatives and range between 1 to 2% of the project cost. The application of this measure will now be expanded, in the case of generating stations, to include initiatives that also foster regional economic development. We plan to consult with interested parties regarding such initiatives.

Current talks with the Atikamekw, the Montagnais, the Inuit and the Crees will continue. It is important to take whatever steps are required so that discussions with Native peoples throughout Québec result in mutually beneficial agreements. We are committed to ensuring that Native communities are partners in the economic development stimulated by hydroelectric projects and that their aspirations are clearly taken into account.

BACKUP GENERATION

Between now and the year 2000, hydroelectricity must be complemented by other means of generation to meet anticipated requirements. Purchases of about 760 MW from independent power producers, mainly in the form of cogeneration, are already planned.

Orientation 21

GIVE PRIORITY TO COGENERATION AS A FORM OF BACKUP GENERATION FROM NOW UNTIL THE YEAR 2000.

Thermal generation from waste and forest biomass will be given priority because of its environmental advantages. Given the current low price of natural gas, reliance on cogeneration from natural gas seems compatible with our calculation of avoided costs. Cogeneration and, to a lesser extent, combined-cycle generating stations, are the forms of thermal generation that cause the least damage to the environment. Direct economic spinoffs from cogeneration are fewer than from hydroelectricity, but may have a positive effect on the development of Québec's main industrial sectors.

Thermal facilities are more attractive when their operation can be coordinated with runoff levels. The relatively short construction lead time for cogeneration is an important factor in flexibility, which makes this type of generation an attractive complement to hydroelectricity.

Orientation 22

INITIATE A PROGRAM OF DRAFT-DESIGN STUDIES FOR MEDIUM-SCALE HYDROELECTRIC STATIONS.

After the year 2000, given the anticipated rise in the cost of natural gas, cogeneration and combined-cycle generating stations are likely to become less attractive. With this in mind, we intend to embark on a program of draft-design studies for medium-scale hydroelectric stations. The main attraction of such facilities is that they provide greater planning flexibility. In addition, such plants could play a greater role by the end of the century, depending on changes in demand.

Given that they can be built within four or five years, medium-scale hydro stations would allow the utility to react quickly if demand grows slightly faster than anticipated. However, for equivalent service, they are generally more expensive than complexes built on large rivers. Furthermore, while medium-scale hydro plants offer greater flexibility in terms of construction, they are generally inflexible in terms of operation because of their limited storage capacity. The main environmental advantage of such facilities is that they do not require large reservoirs. However, it may become necessary to use more thermal generation if a significant number of medium-scale hydroelectric plants are commissioned. The potential interest of these plants nevertheless justifies a draft-design program.

Orientation 23

IMPLEMENT WIND-ENERGY DEMONSTRATION PROGRAMS IN OFF-GRID SYSTEMS.

Wind energy continues to be very costly compared to hydroelectric generation. However, in-depth studies will be conducted to establish the economic value of a future wind-energy contribution to our main system. The situation is different in isolated off-grid systems, since our generating costs are much higher there. We therefore intend to launch demonstration programs in certain off-grid systems, without compromising those systems' reliability. We will invite private-sector promoters to submit proposals and will establish a ceiling price equal to the costs avoided by wind generation.

Means of meeting capacity requirements

Principal and backup generation will make it possible to balance annual supply and demand for electrical energy. But the utility must also be able to meet peak demand. For Hydro-Québec, the peak occurs during cold spells in December, January and February. For these periods, we must have facilities at our disposal that usually provide little energy. To meet peak demand, we are relying on existing facilities, current construction projects, energy conservation, guaranteed purchases from neighboring systems and all the load-management methods already implemented, such as interruptible power and dual-energy heating systems. We also use our interconnections with neighboring systems to reduce the need for new facilities.

Optimizing the possible means of generation to meet peak demand is a complex process with many technical constraints and a wide variation of characteristics and lead times.

Orientation 24

MINIMIZE INSTALLATION OF GAS TURBINES TO MEET PEAK DEMAND.

The installation of gas turbines to meet peak demand will continue to be as limited as possible. Rather, a balance will be maintained between reliance on additional capacity and load management. Load management can provide limited amounts of power within a relatively short time. It therefore works well in combination with additional capacity hydroelectric projects, which require longer execution times. This will ensure diversified means for responding efficiently to peak demand.

Externalities

Orientation 25

STUDY EXTERNALITIES RELATED TO MEANS OF GENERATION.

For several years, we have applied some of the principles of integrated resource planning. Such planning differs from more traditional planning methods in three ways: it includes energy efficiency in the range of options available to meet demand, it takes externalities into account, and it incorporates public consultation. We intend to pursue this approach and to keep improving our planning process, particularly by conducting studies on externalities and by intensifying our research into multi-criteria decision-making aids. These studies will take several years to complete.

4.2 Market development

For a certain number of options, development of markets beyond the level of simply meeting requirements could be envis ged. These options involve relatively small amounts of energy over the next few years, but would require that commissioning of hydroelectric projects be brought forward at the start of the next century.

Electrotechnologies

Electrotechnologies are a group of new or developing electrical technologies which ensure better energy efficiency or higher quality products.

Orientation 26
Foster the use of electrotechnologies.

In general, small and medium-sized companies do not have the financial and technical resources to integrate electrotechnologies into their production processes. However, Hydro-Québec is in a position to contribute to the implementation and dissemination of electrotechnologies through its research and development activities and financial assistance programs.

Electrotechnologies are an excellent way to increase industrial energy efficiency, in addition to stimulating industrial development in Québec. They significantly increase the competitiveness of small and medium-sized businesses, often have a positive environmental impact and provide certain economic benefi's for Hydro-Québec. In addition, for our customers as a whole, electrotechnologies have no effect on the cost of supplying electricity.

Electro-intensive industries

Orientation 27
Promote limited and targeted establishment of electro-intensive industries.

Québec already has a major group of large consumers of electricity in the aluminum and magnesium industries. Consequently, from now on, any efforts to attract electro-intensive industries to Québec should be limited and should target specific industries. Such development would add 180 MW, compared to the 460 MW already provided for in the average scenario described in section 4.4. This limited increase would have relatively little effect on cost of supply, while contributing to industrial development in Québec.

In response to customer expectations about rate increases, public expectations about Québec's economic development, and the concerns expressed during the Development Plan consultation, this orientation will be accompanied by the following conditions:

- Companies must contribute to the strengthening of industrial clusters or the manufacturing of new products in Québec.
- Secondary processing of products in Québec will be encouraged.
- Companies must be energy-efficient.
- Hydro-Québec's financial soundness must not be significantly affected.
- When a specific contract is negotiated, its rate conditions must ensure, for the duration of the contract, revenues equivalent to those provided by the large-power rate applied to major users.

Electricity exports

Orientation 29
FAVOR EXPORT DEVELOPMENT.

We recommend that export development be favored because of its net economic benefits for Québec and because export contracts provide revenues that help bring our rate increases in line with inflation.

Given the energy context, only small additional amounts of electricity would be exported until the year 2000, but larger exports would be possible early in the next century. Growth in sales will depend on the changing demand in neighboring systems and the possibility of developing Québec's hydroelectric generating facilities.

To meet the expectations of our customers and the general public, and to incorporate the concerns expressed during the consultation, this orientation will be carried out under the following conditions:

- Firm electricity and power exports will account for no more than 10% of our firm sales.

- As in the past, each proposed contract will be evaluated on its own merits. The expected return on investment will also have to be sufficient to cover the risks involved.

- No facilities will be built earlier than scheduled without a firm contract.

- Other means of minimizing risk will be considered such as contracts of less than 20 years, or contracts with innovative commercial formulas.

4.3 Research and development

Research and development plays an essential role in carrying out the long-term orientations we propose.

R & D helps maximize the performance of existing generating stations, during rehabilitation for example. In research on power generation, therefore, we intend to emphasize those projects that will enable us to optimize generating station design.

In the area of energy efficiency, the focus will continue to be on demonstration projects designed to support energy conservation programs. Long-term research will also be conducted into energy-efficiency aspects particular to Québec (taking into account climate, type of heating and so forth), as this type of research offers the largest potential benefits to our customers.

In terms of energy use, we intend to maintain our programs for electrotechnology support, as well as our programs on rechargeable ACEP-type batteries, electric vehicles and hydrogen.

Moreover, we intend to expand our areas of long-term research. In addition to the existing nuclear fusion program, work will also begin on new energy sources, particularly photovoltaic energy. Development of wind energy will also continue.

Finally, studies on the environmental impacts of generating facilities will continue to occupy an important place in our research and development activities.

4.4 Evolution of Electricity Demand

The following section presents our forecasts for long-term demand. We will first look at changes in Québec demand, before taking into account initiatives that could modify it, such as energy conservation programs or market development. In the past, such factors were integrated into the base forecasts. Québec's base demand and existing export contracts will be discussed first. This will be followed by total long-term demand, taking into account proposed orientations for market development.

The annex entitled *Forecast Electricity Demand in Québec* provides a detailed explanation of the assumptions used in the forecast.

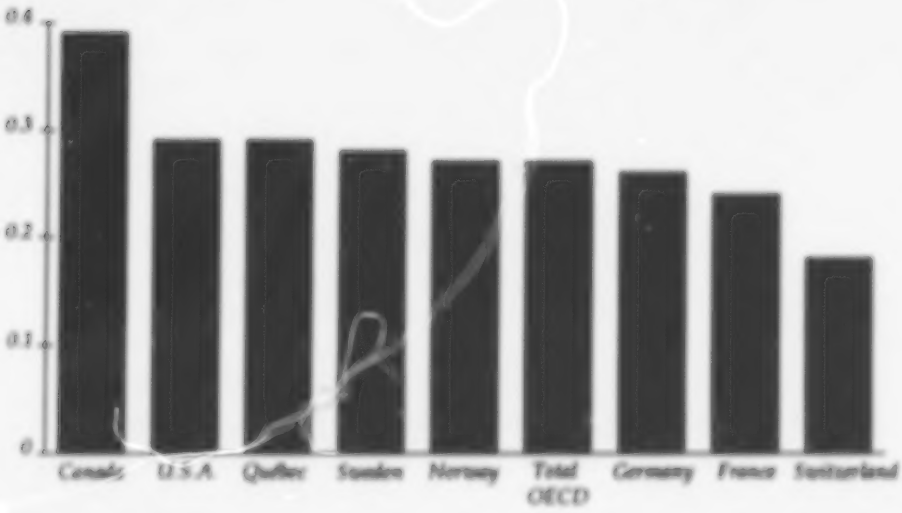
Energy context

When Québec's energy consumption is considered in relation to its gross domestic product (GDP), the result is generally in line with other industrialized countries. It is less than that of Canada as a whole and about the same as that of European countries, as shown in Figure 1.

Figure 1

Energy Consumption in 1989

(TOE per $1,000 of GDP)



In Québec, as elsewhere, overall consumption of energy is increasing very slowly, despite sustained growth in economic activity. In fact, per capita consumption has not increased in 20 years and the ratio between energy consumption and the GDP has even significantly diminished. However, consumption of electricity in Québec grew considerably in the same period, since electricity has greatly increased its market share. The same trend is observed in other countries.

In recent years, the prices of other forms of energy (natural gas and oil) have not increased; in fact, they have declined in relative terms. Although this situation may continue in the short term, it is likely that prices will rise in the long term due to stronger demand for these fuels.

Electricity demand in Québec

In our planning process, we use three demand growth scenarios: high, average and low. We consider the average scenario to be the most probable.

Average scenario

According to this scenario, electricity demand in Québec will grow at an average annual rate of 2.2% between 1992 and 2010. Thus, between 1992 and 2010, sales will increase by approximately 60 TWh. This forecast assumes medium demographic and economic growth and takes into account related structural changes, as well as new uses of electricity that may appear over the long term due to environmental concerns. This scenario is also based on the assumption that current energy-efficiency trends will be maintained, even before taking into account Hydro-Québec's energy-efficiency programs.

The driving force behind this growth in demand will be the industrial sector, with a forecast 2.9% per annum increase between 1992 and 2010, mainly in the areas of smelting and refining, chemicals, and pulp and paper. The average scenario assumes that the pulp and paper industry will continue to face difficulties, and that Québec newsprint will lose part of its US market to producers in the southern United States. However, specialty and fine papers should continue their growth trends. The spread of thermomechanical processes, which require more electricity, should continue, but will be partially offset by standards requiring paper producers to use recycled pulp, which requires less energy.

Demand in the residential and farm sector should grow by 1.3% per annum between 1992 and 2010, mainly due to an increase in the number of households. Finally, demand in the general and institutional sector should rise by 2.2% a year between 1992 and 2010, due primarily to an increase in the number of commercial buildings.

The average scenario takes into account our current commitments with electro-intensive industries (smelting and refining, iron and steel, and chemicals), totaling 960 MW. Between 1993 and 1997, the growth in demand related to these

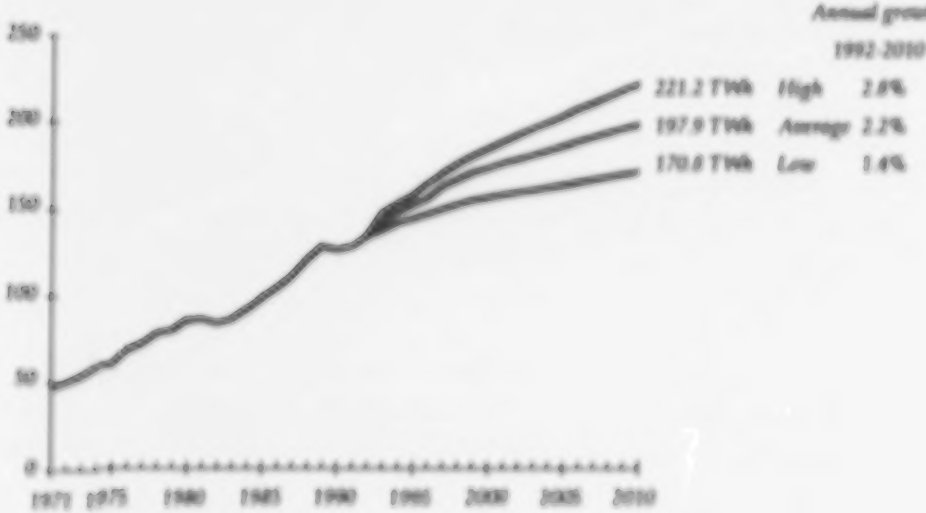
commitments should be relatively high, due in part to the commissioning of new aluminum smelters. In addition to these commitments, the average scenario also calls for expansion projects and new plants totaling 460 MW for the period from 1992 to 2010, without Hydro-Québec marketing initiatives. Of these 460 MW, a first block of 275 MW will come from projects that are very likely to be carried out. However, a number of other projects, particularly those scheduled for after the year 2000, are less certain. Nevertheless, a second block of 185 MW has been added to the average scenario, based on the assumption that 20% of them may be carried out.

High and low scenarios

The high and low scenarios reflect other assumptions about demographic and economic growth that are less probable than those selected under the average scenario, but nevertheless possible. In 2010, the difference between the high scenario and the low scenario is 50 TWh, as indicated in Figure 2. This considerable variance illustrates the level of uncertainty that must be explicitly recognized in our planning process.

Figure 2

Scenarios of Electricity Sales in Québec Before Hydro-Québec Intervention



Signed export contracts

In order to establish total electricity requirements, the long-term export contracts already signed must also be taken into account. The contract with New England Utilities, which terminates in the year 2000, accounts for 7 TWh in firm energy per year. The contract with Vermont Joint Owners, which began in 1990 and will expire in 2020, involves firm capacity and energy, and calls for annual deliveries up to a maximum of 2.5 TWh. Finally, the contract with the New York Power Authority for seasonal power and energy will run from 1999 to 2018. This contract involves deliveries of 3 TWh per year, from April to October.

Overall requirements to be met

Table 7 first shows the overall energy requirements that the utility has to satisfy up until 2010, according to the average scenario without market development. To these figures are then added the requirements that will have to be satisfied, taking into account the proposed orientations regarding market development, as well as the required energy reserve. We propose to base our planning on these energy requirements.

Table 7

Evolution of Overall Energy Requirements According to Average Economic Growth (in TWh)

	1992	1996	2000	2005	2010
Firm electricity sales in Québec	133	156	173	185	198
Deliveries as per agreement and others	7	7	6	6	6
*Export sales**	12	9	12	5	5
Total deliveries	152	172	191	196	209
Electricity losses	13	16	18	19	21
Requirements without market development	165	188	209	215	230
Additional requirements from:					
- industrial development	—	0	1	9	11
- exports	—	0	0	9	9
Requirements with market development	165	188	210	237	262
Required energy reserve	3	4	4	5	6
Total overall energy requirements	168	192	214	242	268

* Several short-term export contracts will expire by 1995.

Table 8 shows the impact of the proposed orientations concerning market development on the growth of capacity requirements, including the required reserve.

Table 8

Evolution of Overall Capacity Requirements According to Average Scenario (in MW)

	1996	2000	2005	2010
Requirements without market development	36,560	39,635	42,660	45,325
Industrial development	60	150	360	630
Additional exports	—	—	1,650	1,650
Requirements with market development	36,620	39,785	44,669	47,325
Required reserve	4,525	4,770	5,130	5,360
Total capacity requirements	41,145	44,630	49,720	52,690

4.5 Balancing Supply and Demand

The overall energy and capacity requirements will first be met using the existing or committed means — i.e. hydroelectric generating stations already in service, long-term purchases already contracted, projects under construction and new planned purchases from independent producers. All our analyses are based on the assumption that our current generating capacity will be maintained and that the rehabilitation work needed to maintain it will be carried out.

However, as Table 9 shows, even after taking into account our existing and committed means, improvements to the existing system and energy efficiency, there will still be energy requirements to be satisfied by the commissioning of new facilities or additional purchases.

Table 9

Energy Balance According to Average Scenario (in TWh)

	1996	2000	2005	2010
Energy requirements to be met	192	214	232	248
Existing and committed means:				
• *Existing facilities and contractual purchases*	173	173	172	172
• *Generating stations under construction (La Grande - Phase II)*	14	14	14	14
• *Independent generation (contracts signed or under negotiations)*	6	6	6	6
Improvements to existing system	1	2	2	2
Energy efficiency	5	10	15	20
Total means identified	197	205	209	214
Variance between requirements and means identified	(5)	9	23	34
Variations in reservoir levels	0	(4)	3	(3)
Additional means needed	0	0	26	55

Since we recommend hydroelectricity as the preferred means of generation, a list of possible projects and their earliest possible date of commissioning is presented in Table 10. These projects would require additional transmission lines that are not included in the table. In fact, the introduction of series compensation gives us greater flexibility, and the extent of the additions will depend on the configuration of the transmission system when it comes time to decide on each of these projects.

Table 10

Possible Hydroelectric Projects to Meet Energy Requirements

Project	Earliest possible date of commissioning	Capacity (MW)	Energy (TWh)
Base-load generating stations			
Lafarge-2	1996	290	1.8
Eastmain-1	1998	665	2.7
Haut-Saint-Maurice	2000	615	2.9
Sainte-Marguerite	2001	820	4.4
Achuapmushuan	2003	730	3.5
Grande-Baleine	2001-2002	3,230	16.2
In reserve			
NBR	*from 2007*	*8,350*	*46.3*
Backup generating stations			
Aguasabonne and Mercier	2001	190	0.9
In reserve			
La Sarcelle, Boyd, Sakami and others	*around 2000*	*500 to 600*	*2.5 to 3*

The commissioning dates presented in this table take into account construction lead times, as well as the time it would take to obtain the necessary authorizations, based on current experience. However, the projects themselves are subject to many uncertainties, which may force us to consider alternative solutions that would probably be more expensive. These alternatives could include increased cogeneration, use of medium-scale hydroelectric stations, additional purchases from neighboring systems and construction of combined-cycle generating stations.

Figures 3 and 4 show the relative importance of the means required, in addition to the generating stations under construction, to satisfy the new energy requirements, including those resulting from market development. Thus, for the 1993-2000 period, energy conservation will satisfy 46% of the requirements, while new hydroelectric projects will satisfy nearly 14%. For 1993-2035, their contributions will be 37% and 36% respectively.

Figure 3

Meeting Energy Requirements: Contribution of New Means — 1993-2000 Period

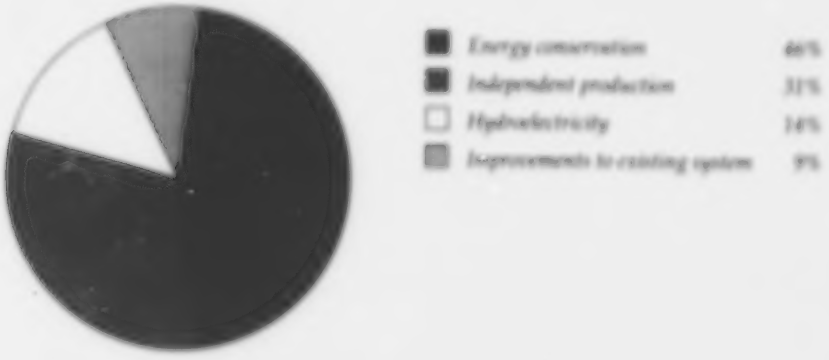


Figure 4

Meeting Energy Requirements: Contribution of New Means — 1993-2035 Period

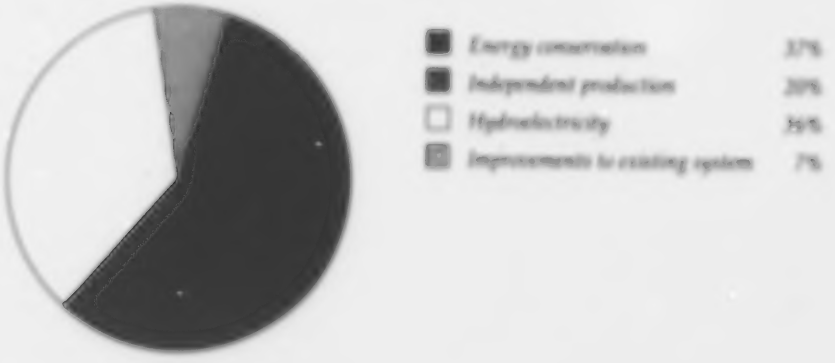


Table 11 shows the capacity requirements during the annual peak-load period and the possible solutions for meeting them.

Table 11

Capacity Balance (in MW)

	1996	2000	2005	2010
Capacity requirements to be met	41,145	44,650	49,720	52,690
Existing and committed means:				
• *Existing facilities and contractual purchases*	33,500	33,425	33,270	33,210
• *Projects under construction*	2,510	2,510	2,510	2,510
(La Grande - Phase II)				
• *Independent generation*	760	760	760	590
Improvements to existing system	200	360	600	600
Energy efficiency:				
• *Energy conservation*	1,050	1,960	2,910	4,080
• *Dual energy*	1,755	1,750	1,500	1,425
• *Interruptible power*	1,200	1,200	1,200	1,200
Reserve pooling	600	600	600	600
Total means identified	41,575	42,565	43,760	44,815
Additional means needed	—	2,010	5,680	7,675

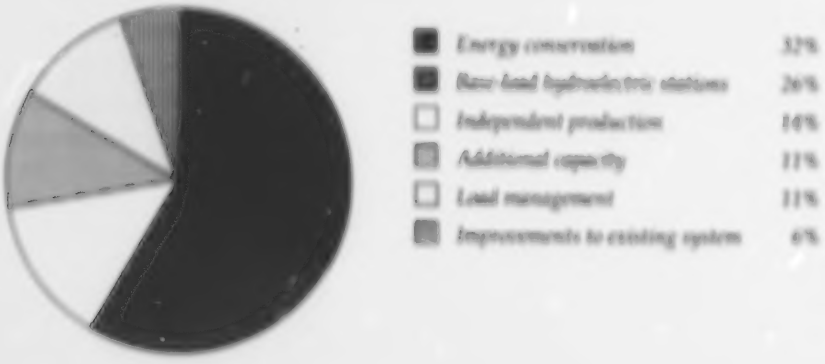
These capacity requirements will be largely met by the hydroelectric projects we have planned in order to achieve a balance in terms of energy. If other means are necessary, we could use a combination of various solutions, as indicated in Table 12.

Table 12
Means Available to Meet Capacity Requirements

	Available capacity (MW)	Earliest possible date of commissioning
Additional capacity		
Manic-3	488	*1999*
Manic-2	320	*1999*
Manic-1	135	*1999*
Outardes-4	550	*2002*
Outardes-3	680	*2002*
Outardes-2	280	*2002*
Other means		
Additional interruptible power	800	*These means*
Expansion of residential dual-energy heating	100	*can be*
Use of customers' existing emergency generators	100	*implemented over a*
Purchases from neighboring systems	100	*relatively*
Gas turbines	*As needed*	*short time*

Figure 5 shows the relative importance of the possible solutions for meeting new capacity requirements. Thus, in 2000, energy efficiency (energy conservation and load management) will satisfy almost 43% of capacity requirements, while hydroelectric base-load and peaking facilities will satisfy another 37%.

Figure 5
Meeting Capacity Requirements: Contribution of New Means in the Year 2000



4.6 Decisions to be made by 1995

The orientations we are proposing in this plan will require various decisions by 1995. Following is a description of decisions for the short, medium and long term, and the dates by which they should be made.

Decisions regarding forecast requirements for the 1996-2000 period

In order to meet electricity requirements for this period, the planned Laforge-2, Eastmain-1 and Haut-Saint-Maurice generating stations must be commissioned between 1996 and 2000. We have included them in the average scenario based on their earliest date of commissioning. In the case of Laforge-2 generating station, construction commenced in the fall of 1992. As for Eastmain-1, the decision on construction start-up should be made in the summer of 1993. With respect to the Haut-Saint-Maurice generating stations, the decision should be made in 1995, with commissioning scheduled for 2000.

If the requirements turn out to be lower than forecast, we will delay the execution of certain projects. However, if they are significantly greater than forecast, the shortfall could be made up by increasing cogeneration and medium-scale hydroelectric stations. In fact, some projects, such as La Sarcelle, Boyd, and Sakami, can be planned for the 2000 horizon.

As regards peak-load facilities, additional generating capacity at Manic-3 station is planned for 1999; the decision to start construction should be made in early 1996. Given the expected increase in interruptible power and in residential dual-energy heating between now and 1996, capacity requirements would then be met.

If the growth in capacity requirements is greater than forecast, we will be able to respond because we have a series of load-management means at our disposal that can be implemented within a relatively short time.

Decisions and public involvement for the 2001-2005 period

To meet the requirements resulting from a market development scenario which calls for additional exports of 1,500 MW, the Grande-Baleine and Sainte-Marguerite projects as well as the Kipawa and Mercier medium-scale projects should be commissioned between 2001 and 2005. These projects represent a total of 4,220 MW or 21.5 TWh. Another 500 MW in additional capacity or load-management efforts would also be necessary. Based on the scenario with market development but without additional exports, we would need base-load generating stations totaling 1,700 MW (approximately 9 TWh), plus about 1,200 MW in additional capacity or load-management efforts.

The beginning of the 21st century will be a very critical period. Regardless of the scenario selected, a substantial amount of new generating capacity is required in the first years of the next decade. A decision on this matter should be made in 1993 or 1994, at the earliest. The choice of hydroelectric project will then depend on the generating stations available, as well as changes in requirements. If none of our major hydroelectric projects can be completed in time, one or more of the following solutions will have to be adopted: medium-scale hydroelectric stations, cogeneration or combined-cycle gas-turbine generating stations. The increase in our costs and rates could be higher in that case.

If demand turns out to be higher or lower, the commissioning dates for hydroelectric projects would be adjusted in order to maintain a balance between electricity supply and demand.

As for balance in terms of capacity, no decision is necessary before 1996 with regard to load-management efforts or adding capacity at existing hydroelectric sites. In the meantime, we will assess the load-management potential much more accurately, and also forge ahead with the draft-design studies for additional capacity at Outardes-4, Outardes-3 and Outardes-2 generating stations, so as to retain all the necessary flexibility.

DECISIONS REGARDING FUNDING REQUIREMENTS FOR THE 2006-2010 PERIOD

For the 2006-2010 period, no decision is necessary before 1995 or 1996. Over the next few years, we will review the long-term balance between supply and demand, in light of changes in requirements. This period will be covered in more detail in the next Development Plan.

4.7 Investments required

From 1993 to 2002, the proposed orientations regarding electricity supply and demand imply investments of $32.9 billion.

Table 13

Investments Required to Maintain the Balance Between Electricity Supply and Demand — 1993-2002 Period

(in $ billions)

Generating and transmission facilities needed to meet energy requirements	*25.3*
Refurbishment of generating stations	*4.0*
Energy conservation, load management and electrotechnology programs	*2.3*
Generating and transmission facilities needed to meet peak-load requirements	*1.4*
Total	*32.9*

5

The expectations of our customers are many and complex. They must not, however, obscure the main source of concern: changes in the price of electricity.

This concern is easily understood. A large majority of our residential customers have chosen electricity for space and water heating. Electricity is therefore a significant component of their budgets, especially in winter. For industrial customers, electricity prices are becoming increasingly important as the globalization of markets intensifies competition for all businesses. Outside Québec, most electricity is still generated from fossil fuels. The decline in fossil fuel prices has slowed growth in electricity costs in competing provinces and states. In the general and commercial sector, electricity costs account for a small portion of customers' overall costs. However, some customers in this sector might be tempted to opt for competing energy sources if the price differential with electricity were to widen.

It is therefore important for us to keep our rates as low as possible, even though, as shown in Table 14, they are already among the lowest in North America.

Table 14

Comparative Index of Electricity Prices (May 1992)*

	Residential 1,000 kWh	Small power 40 kW or 10,000 kWh	Medium power 1,000 kW or 400,000 kWh	Large power 50,000 kW (80% load factor)
Canada				
Montréal	100	100	100	100
Toronto	165	132	158	142 **
Winnipeg	95	70	73	84
Edmonton	114	112	104	—
Vancouver	109	75	75	80
United States				
New York	271	209	208	246
Boston	226	186	169	243
Detroit	223	170	167	203
Chicago	182	160	153	156

*Excluding all taxes.
**According to Ontario Hydro rates.

In order to maintain the competitive advantage of our rates, we propose to align our rate increases, on average, with inflation. This is the benchmark our customers have chosen. Changes in our medium and long-term rates must be in line with changes in our costs and must ensure our financial stability. Permitting our financial criteria to be eroded will not help us supply our customers with electricity at the best possible price: rather, we must slow the growth in our expenditures.

This chapter presents the measures we will introduce in response to our customers' concern over the price of electricity. The following elements will be discussed: energy conservation programs and rates policy, rate increases, cost control and financial policy, and the reduction of cross-subsidization between customer categories.

Orientation 29

GRADUALLY REVAMP THE RATES STRUCTURE TO PROMOTE A MORE RATIONAL USE OF ELECTRICITY AND ALLOW CUSTOMERS TO REDUCE THEIR ELECTRICITY BILLS

In order to make our customers aware of the benefits of energy conservation, we have already launched subsidy programs based on certain energy-saving products. Even taking into account the initial outlay, participating customers will be winners in the medium and long term as their electricity bills decrease.

We propose to gradually revamp our rates structure and to give a more accurate price signal by introducing seasonal rates. Supplying electricity is more costly for the utility in the winter when demand is stronger, forcing us to use more costly facilities. Conversely, supplying electricity is less costly in summer. By offering our customers seasonal rates and by introducing rate options, we will encourage them to better target their energy conservation efforts.

In our opinion, this reform can be implemented fairly quickly in the residential sector and for large companies. In the commercial sector, it should take place more gradually, at the same pace as the simplification of general rates and the reduction of cross-subsidization. Given the current low level of fossil fuel prices, it would not be advisable to raise our winter rates in the commercial sector without implementing other elements of the reform planned for this sector. We intend to proceed cautiously with this reform in order to make sure that we promote energy efficiency rather than a flight to fossil fuels.

At the same time, we are ready to explore new rate formulas with our large industrial customers that would enable them to lower their costs by modifying certain aspects of their operations. Naturally, these new formulas must also have a neutral effect on our overall financial situation so that other customers are not penalized.

Orientation 30

ELECTRICITY RATE INCREASES WITH INFLATION DURING THE 1993-2000 PERIOD.

We propose that the average increase in our electricity rates for the 1993-2000 period should not be greater than inflation. This does not preclude occasionally exceeding the rate of inflation. In years when generating facilities are commissioned, rate increases may exceed inflation; this could be offset by rate increases below inflation during more favourable periods.

Controlling all our costs, especially operating expenditures, is the way to align our overall rate increases with inflation.

Table 15 shows our unit cost structure. For 1992, depreciation, interest expense, long-term purchases, taxes, as well as return on equity — grouped under the heading *Other expenditures and interest* — make up 74% of our total costs, and are relatively difficult to cut back. This is the result of past decisions which today enable us to offer electricity rates among the lowest in North America.

Table 15

Structure of Unit Costs of Supply for Customers Subject to the Rates Bylaw

	¢/kWh		Average annual growth rate
	1992	2000	(%)
Operating costs	1.4	1.5	0.8%
Other expenditures and interest	3.9	5.4	4.3%
Total	5.3	6.9	3.6%

Altogether, the orientations we propose, with the projects already in progress, will require some $53 billion of expenditure between now and the year 2002, that is, $19.6 billion in service-related activities and $32.9 billion to maintain the balance between electricity supply and demand. The orientations we propose will also require us to engage in long-term purchase commitments with independent power producers estimated at nearly $600 million for the year 2000 alone.

As a result, other expenditures and interest will rise from 3.9¢/kWh in 1992 to 5.4¢/kWh in the year 2000. Their average annual growth will thus be 4.3% while the forecast rate of inflation is in the region of 3.5%. To align our average rate increases with inflation, we must therefore achieve productivity gains of around 20% so as to reduce our unit operating costs and bring their annual growth down to less than 1%.

Nevertheless, a number of factors are completely beyond our control, and could make it difficult to align rate increases with inflation. They are: changing levels of demand, interest and exchange rates, tax levels, and runoff.

Growth in demand exerts upward pressure on our expenditures. Our generating projects, although competitive in comparison with other types of generation, are increasingly expensive. In addition, hydroelectricity requires large quantities of capital. The cost of capital is directly related to real interest rates (nominal rates minus inflation) and, to a lesser extent, changes in exchange rates. Real interest rates, although relatively low during the 1970s, have been very high since the early 1980s. Canadian government monetary policies and the slowdown of inflation suggest that these rates may drop eventually, but not to the low levels seen in the 1970s. In fact, we are forecasting only a modest decline in real interest rates.

If real interest rates do not fall as forecast, or if they rise, the increase in our costs will be more pronounced. Exchange risk, however, can to a large extent be managed by the use of swaps and other hedging tools. For tax levels and debt guarantee fees, our projections are based on current rates.

We also propose to create a stabilization fund to offset the main financial risk associated with hydroelectricity: runoff levels. This fund would allow revenue obtained from sales of surplus energy during high runoff cycles to be used to finance exceptional means of generation during low runoff periods. Such a mechanism would help stabilize our financial results and better protect our customers against rate shocks. In recent years, low runoff levels have cost us close to $700 million; they have resulted in sharper rate increases and deterioration in our financial ratios. As runoff fluctuations can adversely affect our financial structure, the creation of a stabilization fund appears justified since such a fund is one of the few means available to manage this risk.

Containing expenditures

A comparative analysis of our operating costs indicates that notwithstanding the advantage conferred by hydroelectricity, our performance falls short of the most efficient electric utilities.

In order to reduce this gap, we must substantially increase our productivity so as to contain the growth in our operating costs. The additional pressure exerted on costs by, for example, the commissioning of new facilities will have to be absorbed by these productivity gains. We are targeting a cumulative gain on the order of 20% by the year 2000.

Priority areas of action are corporate organization and the optimization of our main working methods. We will progressively adopt the techniques observed in the most efficient utilities. This reform of our working methods will be based on management strategies that encourage the transfer of human resources from areas in decline, such as support activities, toward areas experiencing growth, that is, mainly those associated with the direct supply of products and services.

We also intend to rationalize our investments and thoroughly review the methods we use to design and execute our projects, in order to reduce their costs. In this case, by applying the principles of quality assurance to both our internal procedures and relations with our suppliers, we will be able to reduce the costs of non-quality.

As regards expenditure control, our fundamental and ultimate challenge is to achieve permanent gains without affecting the realization of our other improvement objectives.

[illegible]

A whole series of measures is intended to increase our revenues. They vary in importance, but their overall effect will be significant.

For example, the recovery of bad debts, which is based on the principle of fairness, also contributes to limiting rate increases. At the end of 1991, bad debts amounted to nearly $70 million. We expect to reduce them considerably in coming years, in order to achieve results comparable to those of Canada's most efficient utilities.

With this goal in mind, we plan to improve the quality of information in our files; make sure that our new commercial customers provide the required payment guarantees at all times; adopt a firmer approach toward customers whose payments are overdue (reminders, payment arrangements, service interruption notices); and apply our service interruption procedure more quickly to customers who have exceeded the deadlines, while avoiding power cuts to residential customers during the winter.

Still with a view to increasing our revenues, we will use our interconnections to purchase and resell power and will intensify the marketing of the high-technology products we develop. It is also worth noting that revenues from export contracts will help us to align rate increases with inflation.

Financial policy

Orientation 01

Consolidate our financial position by optimising our financial ratios.

Our activities require large amounts of capital, which means that we must regularly turn to the financial markets. In order to ensure that we obtain good financing conditions, we aim to maintain the following ratios:

- interest coverage of more than 1.0;
- capitalisation of at least 25%;
- self-financing ratio of at least 30%;
- return on equity at least equal to the cost of the debt.

We review the levels of these ratios periodically to ensure they are appropriate. We will, in particular, continue the self-financing ratio in light of changes in our cost structure and planned investments.

In accordance with these overall criteria, our rates policy for markets subject to the Rates Bylaw is to reflect the costs of supplying these markets, while at the same time ensuring a return on equity comparable to that observed in other types of utilities.

Aligning our electricity rate increases with inflation should enable us to maintain interest coverage of more than 1.0 and a self-financing ratio of more than 30% between now and the year 2001. But such rate increases would not allow us to respect two other financial criteria every year: a capitalisation ratio of at least 25% and an overall return on equity at least equal to the cost of the debt. These two criteria will be restored once the commissioning of facilities now under construction is over, and once our long-term objective for increased productivity have been achieved.

Orientation 02

Progressively reduce cross-subsidization between markets.

In recent development plans, we emphasized that income from customers subject to small and medium-power rates helped to finance the service provided to other customer categories that enjoy rates which are lower than they should be. We also explained that this cross-subsidization, besides being inequitable, presents commercial and financial risks. The real reduction of cross-subsidization during the last few years has been very low; we are therefore resolved to reduce it gradually between now and the year 2001.

Conclusion

The proposals discussed in this document are intended to contribute to the discussion of the future of electricity, especially Hydro-Québec's medium and long-term orientations. The options recommended are those which we feel, all things considered, are the most advantageous for our customers and for Québec as a whole.

This document is the result of a process combining analysis and dialogue. It has been developed as a function not only of our studies, but also of the expectations expressed by our customers and the comments made by the many groups that took part in our consultations.

We intend to maintain this process and to constantly refine it. For example, we will make more systematic use of integrated resource planning, which makes it possible to weigh all the advantages and disadvantages of the options analyzed. We will also continue to listen to our customers and to hold public consultations, both on an ongoing basis.

Dialogue is essential to our progress. Only in a climate of openness – and by relying on the motivation and know-how of all our employees – will we succeed in being recognized by the year 2000 as Canada's foremost electric utility for the quality of its services and, at the same time, as a major partner in Québec's sustainable development.

We hope our proposals will give rise to an enlightened and constructive discussion in which all participants are motivated by the same concern for the common good. For our part, we will continue to work resolutely for the well-being of the community. And our fundamental goal, as a utility serving the public, will always remain total satisfaction of customer needs.

Overview of Proposed Orientations Development Plan 1993

SERVICE

QUALITY OF CUSTOMER SERVICE

Orientation 1 CONTINUE TO IMPROVE BASIC SERVICE AND MAKE IT MORE PERSONAL.

Orientation 2 DO MORE TO HELP CUSTOMERS MANAGE THEIR BILLS AND CONTROL THEIR CONSUMPTION.

PRODUCT QUALITY

Orientation 3 CONTINUE IMPROVING CONTINUITY OF SERVICE.

Orientation 4 ENSURE THAT POWER QUALITY FULLY MEETS THE OPERATING REQUIREMENTS OF CUSTOMERS' EQUIPMENT.

ENVIRONMENTAL AND SOCIAL RESPONSIBILITY

Orientation 5 PROTECT PUBLIC HEALTH.

Orientation 6 DO MORE TO PROMOTE SAFETY NEAR OUR FACILITIES.

Orientation 7 PROTECT QUALITY OF LIFE AND THE ENVIRONMENT, AND MANAGE WASTE FROM OPERATIONS MORE EFFECTIVELY.

Orientation 8 MAXIMIZE ECONOMIC SPINOFFS FROM OUR ACTIVITIES.

HUMAN RESOURCES AND MANAGEMENT

Orientation 9 ENSURE THAT EMPLOYEES EMBRACE THE QUALITY CULTURE.

Orientation 10 ENHANCE THE KNOW-HOW OF OUR EMPLOYEES.

Orientation 11 IMPLEMENT A MORE EFFICIENT STRUCTURE AND WAY OF MANAGING.

Orientation 12 IMPROVE OCCUPATIONAL SAFETY.

Orientation 13 ENSURE THAT WOMEN AND MINORITIES ARE BETTER REPRESENTED IN OUR WORKFORCE.

TECHNOLOGY

Orientation 14 AIM TO DEVOTE 2% OF OUR ANNUAL SALES TO R & D.

Orientation 15 ENCOURAGE NETWORKING WITH INDUSTRY, UNIVERSITIES AND RESEARCH CENTRES.

Orientation 16 INTENSIFY THE MARKETING OF TECHNOLOGICAL PRODUCTS RESULTING FROM OUR RESEARCH.

Long-term electricity supply and demand

Means

Orientation 17 Give priority to improving the existing system and to energy conservation.

Orientation 18 Continue to target annual energy savings of 9.3 TWh in the year 2000.

Orientation 19 Give priority to hydroelectricity, including small facilities operated by independent producers, for principal generation.

Orientation 20 Work with communities affected by hydroelectric projects.

Orientation 21 Give priority to cogeneration as a form of backup generation from now until the year 2000.

Orientation 22 Initiate a program of draft-design studies for medium-scale hydroelectric stations.

Orientation 23 Implement wind-energy demonstration programs in off-grid systems.

Orientation 24 Minimize installation of gas turbines to meet peak demand.

Orientation 25 Study externalities related to means of generation.

Market development

Orientation 26 Foster the use of electrotechnologies.

Orientation 27 Promote limited and targeted establishment of electro-intensive industries.

Orientation 28 Favor export development.

The price of electricity

Orientation 29 Gradually revamp the rates structure to promote a more rational use of electricity and allow customers to reduce their electricity bills.

Orientation 30 Align our rate increases with inflation during the 1993-2000 period.

Orientation 31 Reinforce our financial position by attaining all our financial ratios.

Orientation 32 Significantly reduce cross-subsidization between markets.

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ANNEXES

1. Consultation Report
2. Energy Efficiency
3. Means of Generation
4. Contribution to Québec's Economic Development
5. Long-Term Exports and Use of Interconnections
6. Forecast Electricity Demand in Québec
7. Long-Term Rate Orientations

WORKING DOCUMENTS

Combinations of Options — Impacts
Combinations of Options — Methodology for Impact Analysis
Improvements to the Power System
Environment
Technological Progress and Efficient Use of Electricity

To obtain these documents, send a written request to:

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Legal deposit — 4th quarter 1992
Bibliothèque nationale du Québec
National Library of Canada
ISBN 2-550-26745-1
92-181-A
Ce document est disponible en français.